E ENGINEERING CONSTRUCTION WEEKLY · BRIDGES · IRRIGATION · FLOOD CONTROL · FOUNDATIONS · DAMS ·

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JAN 17 1938

Engineering NEWS-RECORD

January 13, 1938

What's Ahead for Roadbuilding in 1938?

GHWAYS · WATERWORKS · STREETS · SEWERS ·

PROTECT AGAINST Locomotive Blasts with BYERS WROUGHT IRON

• For the protection of bridge understructures that must withstand sulphur-laden locomotive blasts, Byers Wrought Iron blast plates are today being used in increasing quantities. Railroad and highway engineers have united to stamp out the unnecessary expense caused by leaving valuable bridge structures unprotected. Illustrated is the Eastern Avenue bridge over the C. R. I. & P. Railroad at Oklahoma City. This fine, new structure is now protected with Byers Wrought Iron Blast Plates.

There is a wealth of evidence already available to back up the use of wrought iron for bridge protection. This subject is thoroughly discussed in a special bulletin. Byers Wrought Iron withstands sudden and extreme changes in temperature without cracking and affords maximum protection from corrosive locomotive blasts without adding undue weight. Ask our nearest Division Office for a copy of "Wrought Iron in Bridge Construction" or write our Engineering Service Department in Pittsburgh. A. M. Byers Company. Established 1864. Pittsburgh, Boston, New York, Philadelphia, Washington, Chicago, St. Louis, Houston, Seattle, San Francisco.

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· ENGINEERING NEWS-RECORD ·

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Vol. 120 *JANUARY 13, 1938* No. 2

THIS WEEK AND NEXT

A YEAR of highway progress that will carry on through 1938 and the years to come is signalized in the pages of this issue.

From a complete census of the 48 states figures have been assembled of the roadbuilding of the past year and of the budgeted expenditures for the year just begun.

The growth in road income, the changing trends in highway types, and the increase in accidents are indicated by statistics, charts and tables.

Progress by state highway departments in design and construction is reported by some forty state highway engineers in signed articles.

Construction-materials progress is discussed by technologists in production, and the improved use of these materials is described by authorities in bituminous, concrete and brick construction and in soil stabilization.

Broad reviews of current planning surveys, highway research, construction methods and design for modern traffic speeds have been prepared by division heads of the federal bureau of public roads.

A special 7-page section devoted to notes from Field and Office that are of special interest to highway engineers is included. It has a well-balanced selection of practical aids to both the man in the laboratory and the man on construction.

Three full pages of pictures show grading equipment, bridges and means of planning for the future by investigating present conditions.

NEXT WEEK—Winter and the Waterworks, an account of how Eau Claire, Wis., meets the problem of deep frost penetration. Also, progress on the new Mississippi River bridge at Baton Rouge.

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Number of copies of this issue printed: 33,614

An Invitation –

TO A GRAPHIC DEMONSTRATION OF EXPANSION AND CONTRACTION OF CONCRETE HIGHWAYS

●●●

Up goes the temperature and Truscon Air Cushion Expansion Joints absorb the terrific stresses and strains of expansion in concrete highways. Down goes the temperature and Truscon Contraction Plates compensate for the rapid contraction of concrete and prevent destruction of roads and highways.

This is what Truscon's exhibit at the National Road Show and Convention dramatizes for you at Booth D-45 in the Exhibition Hall of the Auditorium at Cleveland, Ohio, January 17 to 21, 1938. Truscon representatives will be present to welcome you and explain the many advantages provided by Truscon's complete line of highway products.

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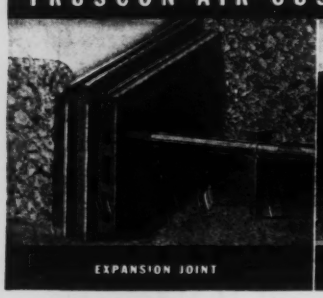
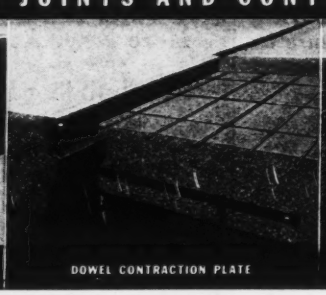

EXPANSION JOINT

ROAD FORMS


DOWEL CONTRACTION PLATE

TRANSVERSE CONTRACTION PLATE

THE WEEK'S EVENTS

Transmountain Tunnel Found Feasible

Colorado-Big Thompson project approved over opposition of park and conservation interests

The Colorado-Big Thompson $31,703,000 transmountain diversion project passed its final step preliminary to start of construction with the approval by the President of a finding of feasibility by the Secretary of the Interior. The finding was made over the protests of organizations interested in conservation and recreation and of the National Park service, protests arising from fear that the tunnel, which is routed under Rocky Mountain National Park, might do injury to the park (*ENR* Nov. 18, 1937, p. 808).

Entire sympathy with the opposition was felt by Secretary Ickes, he said, but action of Congress in approving the project and in appropriating $900,000 to start construction, left him no choice but to approve it. He pointed out, however, that no precedent was set, since the Rocky Mountain National Park, unlike other national parks, is reserved for reclamation use in the act establishing it.

Features of project

The project contemplates diversion of 300,000 to 320,000 acre-ft. of water annually from reservoirs on the Colorado River side of the continental divide through a 13.1-mi. tunnel to the drainage basin of the South Platte River, supplementing the irrigation of 615,000 acres in the South Platte basin.

The Green Mountain Reservoir, costing $3,576,000, will be created by a dam of the compacted earth embankment type 258 ft. high and with a crest length of 1,000 ft. The reservoir will have a capacity of 152,000 acre-ft. This reservoir, on the Blue River, will store water on the western slope.

The major portion of the western slope storage, amounting to 462,000 acre-ft., will be accomplished in Granby reservoir on the Colorado River, which will be formed by an earth embankment dam 223 ft. high and 720 ft. long, built at a cost of $2,814,000. A third dam, the long North Fork, 48 ft. high and 350 ft. long will create Shadow Mountain lake, an extension of the present Grand Lake, at a cost of $484,000, reducing the length of the Continental Divide tunnel about 7½ miles.

Major item in the project is the Continental Divide tunnel, 13.1 miles long, 9½ ft. in diameter, and with a capacity of 550 sec.-ft. It will run from just outside the western boundary of Rocky Mountain National Park to a point just outside the eastern boundary, and will be excavated entirely from the two portals. It will cost $7,271,000.

Storage on the eastern slope will be provided by three reservoirs, Carter Lake, Horseshoe and Arkins. These reservoirs, with a total capacity of 256,000 acre-ft., will be formed by compacted earth embankments, of which the highest will be 190 ft. high and the longest 1,500 ft. long, costing $7,410,000.

Additional structures include a 12.6-mile canal to divert waters of Willow Creek into Granby reservoir; a pumping plant and 4½ mile canal to raise water from Granby reservoir through a 130-ft. lift to Shadow Mountain lake.

Power will be generated on the eastern slope at a 30,000-kw. power plant connected with the east portal of the tunnel by a 5.4-mile conduit. About a quarter of the power generated will be used at the Granby pumping plant, and the remainder will be available for commercial purposes. The power plant and canal will cost $2,879,000.

MAJOR NEWS

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Regular Federal Aid Bill Introduced

District of Columbia would be included in allotments on same basis as states

Disregarding the plea for a reduction in federal aid to the states for highways made by President Roosevelt in his highway message to Congress and repeated in his budget message (*page 42*), Representative Cartwright, chairman of the House roads committee, introduced into Congress Jan. 6 a bill authorizing the regular federal-aid expenditure during the fiscal years ending in June, 1940 and June, 1941. For each of these years $125,000,000 is authorized for the federal-aid highway system; $25,000,000 for secondary and feeder roads; $50,000,000 for grade crossing elimination projects; $14,000,000 for forest highways, roads and trails; $2,500,000 for roads through federally owned land; $7,500,000 for roads, trails and bridges in national parks; $10,000,000 for roads providing access to or connecting with national parks; and $4,000,000 for roads on Indian reservations.

The bill continues the provision that a state may expend 1½ per cent of the amount apportioned to it for "surveys, plans, engineering and economic investigation of projects for future construction . . . either on the federal-aid highway system and extensions thereof or on secondary or feeder roads."

New provisions

The present bill introduces a provision entitling the District of Columbia to share in federal-aid funds in a proportion calculated on the same basis as the allotment to the states. It is provided, however, that selection of roads in the District of Columbia on which federal-aid funds are to be expended may be made without regard to the requirements in the Federal Highway Act that such expenditures be made on a definite system of highways within the state which expedites the completion of a connected interstate system of highways.

Two new provisions increasing the control of the Secretary of Agriculture

(Continued on page 44)

WATERS FROM THREE DIRECTIONS

THIS IS NOT A FLOOD SCENE. It is simply high tide in an area where the San Francisco Bay shore is subsiding. Subsidence of lowlands in the Santa Clara Valley near the southern end of San Francisco Bay is being observed by precise-level parties at regular intervals and careful attention is being devoted to the analysis of probable causes. Meantime the situation has become critical in that portion of the affected area which was close to water level before subsidence began. Although the maximum subsidence has occurred in the business district of San Jose, where the total to date is about 5 ft., lands bordering the shore of San Francisco Bay have gone down enough to make dikes necessary to keep out flood tides. The great length of the bay enables wind to drive a high tide to a still higher level.

Winter storms with attendant floods in stream channels create the unique problem of keeping tidewater out by dikes without flooding the area with rain water impounded by the dikes. This is accomplished by flood gates in the dikes which permit the impounded water to escape at low tide.

These are irrigated lands which pump the water for irrigation from wells. Already salt water infiltration has rendered much land unfit for crop production.

The accompanying picture was taken near the town of Alviso, where waters are encroaching from three directions: (1) Salt water comes inland from the Bay to lap the dikes and (2) seeps into underground water basins, while (3) winter freshets in Santa Clara Valley streams flow into the valley areas which have been cut off from the bay by dikes.

Tuttle Named Consultant On New York WPA

Until recently director of the PWA in New York State, Arthur S. Tuttle has been appointed consulting engineer for the WPA program of New York City. Aided by his experience as former chief engineer of the city Board of Estimate and Apportionment, Mr. Tuttle will devote himself to the development of a long-rang program of construction projects to be undertaken for the city by WPA.

Born in Burlington, Conn. and educated at New York University, Mr. Tuttle served from 1884-1901 as assistant engineer of the Brooklyn Water Works, leaving that task to head an investigation for a proposed water and irrigation development in Hawaii. A year later he returned to the city service as principal assistant engineer and then deputy chief engineer of the Board of Estimate, leaving that post to enter private employment as construction engineer for the National Meter Co. He returned to public service in 1921 to serve for seven years as chief engineer of the Board of Estimate and for five more as consulting engineer for the board. In 1933 he became consulting engineer for the Citizens Budget Commission and a member of the New York City administration for work and home relief, and later in that same year, was appointed New York State engineer for the PWA and then state director of the PWA, a position from which he resigned last year.

Mr. Tuttle is a past president of the American Society of Civil Engineers.

• • •

Deer Creek Dam Bids Asked

Bids for construction of the Deer Creek Dam of the Provo River reclamation project in Utah and for relocation of railroad and highway lines affected by the project, will be opened Feb. 10. Salt Lake City recently voted to participate in the project to obtain more water (*ENR* Dec. 9, 1937, p. 962).

The dam, for construction of which 1,350 days will be allowed, is located on the Provo River about 15 miles northeast of Provo, Utah. It will irrigate about 40,000 acres of cultivated land and provide water supply for Provo, Orem and Salt Lake City.

Sewage Plant Progress In Chicago District

Sewage plant construction in the Chicago Sanitary District cost $8,024,000 in the second half of 1937, bringing the total expenditure since the program was started in 1916 to $150,224,000. This work, the sanitary district asserted in its semi-annual report to the Supreme Court, has brought consumption to a point where diversion of lake water for dilution purposes can be reduced to 1,500 sec.ft. at the end of 1938, thus carrying out the order which the court handed down in 1930. Average diversion this year has been a little under 5,000 sec.ft.

The district, with 4,587,000 population and an industrial load equivalent to 1,805,000 additional population, now treats 41.6 per cent of its sewage; completion of plants now under construction will permit treatment of about 75 per cent.

About $11,000,000 is now on hand from unspent PWA money and will be sufficient for the current year's construction program. Hereafter $15,750,000 will have to be provided.

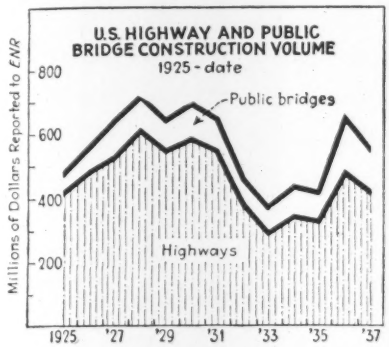
THE CURRENT TREND

This week's news of contract volume and construction cost factors

Highway Volume Lower

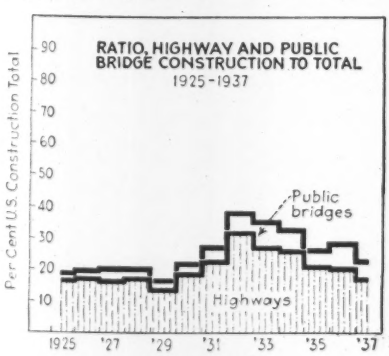
Middle West and Southern territories gain in percentage of United States total

Highway construction volume for 1937, both rural and urban, totals $415,000,000 as reported by *Engineering News-Record*. Public bridge construction adds another $125,000,00. These figures represent projects throughout the 48 states of $25,000 or more in value.

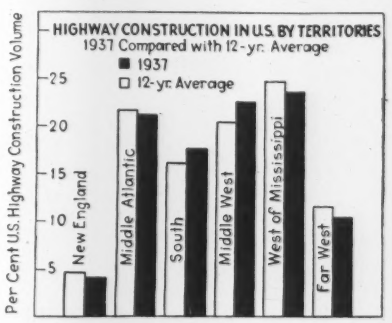


This 1937 highway total is 14 per cent under the corresponding 1936 value, is slightly below 1925 and exceeds only 4 annual totals, 1932, 1933, 1934 and 1935. The low volume in 1937 compared with other years is due to lower city and local, county and township, construction activity since state highway construction volume, reported in detail in this issue, gives 1937 a higher ranking compared with previous years.

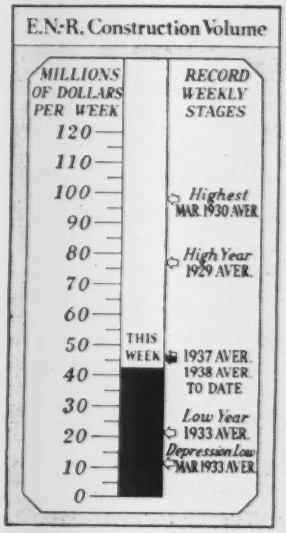
Bridge construction activity reached an all time high in 1936 which the high volume of 1937 did not succeed in duplicating. Combined bridge, street and road volume in 1937 accordingly is 16 per cent under the 1936 record. It exceeds the annual totals for 1925, 1932, 1933, 1934, 1935 and is only slightly under 1926. However, 1927-'31 and 1936 all exceed 1937 by an average of more than 16 per cent.



Highway and bridge construction in 1937 accounted for 22 per cent of the total volume recorded by *Engineering News-Record*, approximately the 1930 ratio but higher than the 1925-'29 ratio. Highways alone accounted for 17 per cent, slightly more than the 1925-'28 average. Highway construction volume in the depression years declined less than most types of construction, hence its relative importance in maintaining the construction total increased. Thus in 1932 street and road construction was 31.2 per cent of the *ENR* recorded total. With the addition of public bridges this ratio is raised to 37.7 per cent. From this peak there has been a fairly uniform return to the approximately normal ratio to the total recorded for 1937.



A shift geographically, of highway volume into the middle western and southern states is recorded for 1937, compared with the preceding 12 years. This makes Middle West the second largest territory and South the fourth largest in highway volume. West of Mississippi, the largest territory for highway construction, averaged almost 25 per cent of the country's total from 1925 through 1936, Middle Atlantic, 22 per cent, Middle West, 20½ per cent, South, 16 per cent, Far West, 12 per cent, New England, 5 per cent. Corresponding distribution of 1937 street and road construction is 24, 21, 22½, 18, 10½, 4.



THIS WEEK'S FIGURES

(Thousands of Dollars)

CONTRACTS

	Week Ending Jan. 14 1937	Jan. 6 1938	Jan 13 1938
Federal	$2,863	$2,466	$2,478
State & Municipal	21,442	28,400	24,321
Total public ...	$24,305	$30,866	$26,799
Total private ...	19,584	18,312	15,791
TOTALS	$43,889	$49,178	$42,590

Cumulative
1938 (2 weeks) $91,768
1937 (2 weeks) $84,336

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1937 2 Wk.	1938 2 Wk.
NON-FEDERAL	$14,193	$16,453
State & mun. bonds..	11,178	12,560
Corporate securities.	2,140	1,893
PWA loans, grants..	875	.....
RFC loans	.....	2,000
FEDERAL	.....	.....
TOTAL CAPITAL ...	$14,193	$16,453

ENR INDEX NUMBERS

Index Base	1913	1926
Construction Cost (Jan.).....	243.85	117.22
Construction Volume (Dec.)..	141	62

State highway construction in 1938 should show an increase of 12½ per cent on the basis of present budgets and federal aid. Urban and local county and township expenditures will probably not make so favorable a showing although these, too, will enjoy increased revenue from the higher gasoline and motor vehicle tax collections in 1937.

• • •

THE AMERICAN APPRAISAL CO. cost index for November, 184, remains unchanged from October. This value is 17 points higher than November, 1936.

Reduce Public Works President Asks

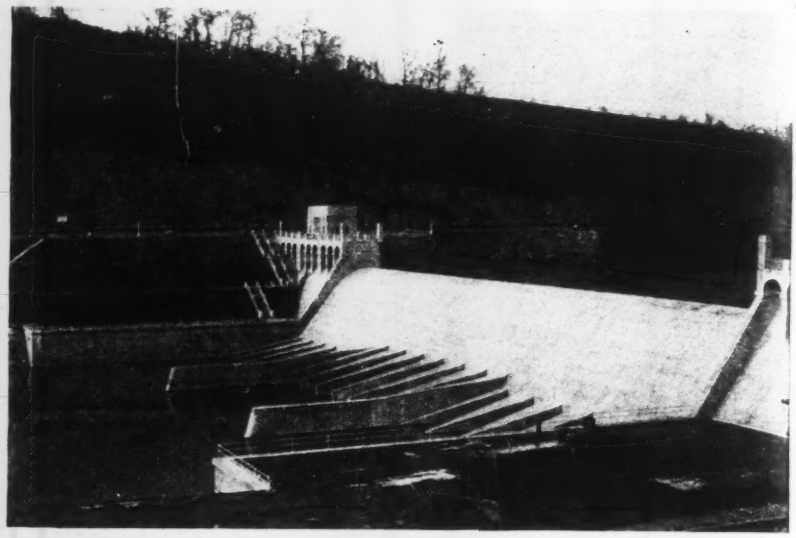
Budget message recommends $137,000,000 cut in regular public works program

Federal expenditures for capital improvements, such as highways, river and harbor improvements, flood control projects, public buildings, and reclamation, will bear the burden of governmental economy during the coming fiscal year, according to the budget estimates transmitted to Congress by President Roosevelt last week.

The President recommends that federal aid for highways be reduced to the pre-depression level, river and harbor improvements be slowed down, no new reclamation projects be started, and the construction of public buildings be sharply curtailed. The sole offsetting factor is an admission that flood control work is urgently needed to protect human lives, so that part of the saving in river and harbor work will be switched to flood control, increasing the total recommended appropriations in the latter category from $52,500,000 to $76,000,000.

In his message accompanying the budget, the President pointed out that other classes of federal expenditures, including debt interest, pensions, social security contributions, the support of the routine activities of the government, and the various forms of relief are either relatively inflexible, or could be reduced only by depriving large sections of the population of the benefits modern civilization insists on.

Regular appropriations for the general public works program, not including amounts taken from relief allotments, proposed for the 1939 fiscal year as compared with previous allowances, are shown below.



A FLOOD CONTROL PROJECT NEARS COMPLETION

DOVER DAM is one of the fourteen dams of the Muskingum Conservancy District project. The $44,000,000 project is now nearing completion, with only a few small jobs left to complete. Dover Dam is the only all-concrete structure of the fourteen dams in the Muskingum project.

Taking into account all funds, regular and emergency, the proposed cuts in expenses for public works are as follows, in round numbers: highways, $140,000,000; TVA, $5,000,000; reclamation, $9,000,000; rivers and harbors, $21,000,000; flood control, $7,000,000; public buildings, $21,000,000; and PWA grants, $36,000,000. The cut in PWA grants may be less than indicated because the Supreme Court decision in the Duke power case releases commitments for municipal power.

Expenses of the Civilian Conservation Corps were cut nearly one-third, reducing them to an estimated $230,000,000, or $123,669,000 less than last year. The sum of $1,576,000 for the Federal Power Commission is an increase of $34,500 over last year, to cover the increasing duties of the commission under the amended Federal Power Act. The Rural Electrification Administration is allotted $30,000,000 for loans, plus $1,520,000 for administrative expenses.

EXPENDITURES RECOMMENDED IN BUDGET MESSAGE

	Fiscal year ending June 30, 1939	1938	1937
Tennessee Valley Authority	$40,000,000	$40,166,270	$39,900,000
(Plus, in each case authority to incur $4,000,000 for future delivery.)			
Dept. of Agriculture (total)	100,000,000	180,000,000	68,000,000
Federal-aid highway system	63,000,000	150,000,000	60,000,000
Secondary or feeder roads	10,000,000	5,000,000	.....
Grade Crossing elimination	20,000,000	10,000,000	.....
Public land highways	.....	2,500,000	.....
Forest roads and trails	7,000,000	12,500,000	8,000,000
Dept. of the Interior			
Bonneville distrib. system	1,450,000	.....	.....
Reclamation—misc. projects from Reclamation fund	7,410,000	9,850,000	10,860,000
Other projects from general fund:			
Central Valley, Calif.	9,000,000	12,500,000	6,900,000
Grand Coulee, Wash.	13,000,000	13,000,000	20,000,000
Colorado River, Tex.	2,030,000	.....	.....
Total—Bur. of Reclamation	36,390,000	40,375,000	54,610,000
National Park Service			
Roads and trails	3,000,000	4,500,000	6,500,000
Blue Ridge and Natchez Trace	4,000,000	6,000,000	.....
Total, Nat. Park Serv.	7,000,000	10,500,000	6,500,000
Treasury, Procurement			
Pub. bldgs. outside D. C.	11,000,000	33,107,066	60,000,000
do , Dis. of Col.	3,500,000	2,325,000	2,200,000
Wart Dept.			
Bldg. constr. at mil. posts	9,348,517	9,382,050	.....
River and harbor impvt.	30,000,000	90,822,101	120,750,000
Flood Control, Miss. Riv.	26,000,000	22,500,000	16,000,000
do , other	50,000,000	30,000,000	.....
Total, War Dept.	115,348,517	152,704,151	141,050,000
TOTAL	343,130,517	480,010,862	395,719,200

More Road Money Urged in N. Y.

A drastic increase in annual appropriations from current revenues for highway construction and reconstruction in New York State as well as for public buildings was recommended in the report of the joint legislative committee on state fiscal policies, a body created by the State legislature last year. Greatly curtailed highway expenditures during the past six years, the committee found, put the state under the present necessity of spending at least $34,000,000 a year for maintenance and reconstruction.

Existence on the state highway system of 1,000 miles of unimproved highway, 1,600 miles needing complete reconstruction, 1,800 miles needing resurfacing, and 1,800 miles urgently in need of widening necessitates new construction which would bring the required minimum annual expenditure to $75,500,000, including federal aid funds.

Baltimore Collects Own Refuse

Adopts municipal refuse collection on consulting engineer's recommendation

Baltimore has abandoned private contract services for the collection of rubbish and on Jan. 1 took over this work using municipal forces. The change was made in accordance with recommendations recently submitted by Abel Wolman, consulting engineer, and is in line with an earlier report in 1931, when he recommended contract service for a period of five years, during which time the city could develop a program for municipal collection. Garbage has been collected by the city for a number of years. Garbage and most of the rubbish is incinerated by the contractor.

In his report, Mr. Wolman points out that private contract services for the collection and disposal of refuse in Baltimore during the last five years have been carried out with efficiency and financial advantage to the city. Savings to the city over the procedure formerly used approximated $2,000,000 in the period 1933-36. A comprehensive review of the situation had been requested by the Mayor and the Board of Estimates because charges had been made that favoritism was shown when the contract was awarded in 1932.

The contractor, The Foreman Co. of Baltimore, was low bidder at that time for supplying rubbish collection service and for the incineration of garbage collected by the city. The contract called for the construction of a 600-ton incinerator which was to be operated by the contractor for ten years, after which it became the property of the city; the collection contract was awarded for only a five-year period. The Foreman Co., lowest of four bidders, received the award at the following prices:

$4.10 per ton for collection and hauling
$0.80 per ton for incineration of rubbish
$1.85 per ton for incineration of garbage

"On the basis of cost alone," said Mr. Wolman, "Baltimore is receiving a service in the incineration of garbage and rubbish at a cost lower than that achieved by other municipalities and at a cost lower than that which the city itself is able to accomplish in its present incinerators." A study of the cost per ton of material incinerated showed that this varied from $1.79 to $2.88 in cities of the United States and Canada; Baltimore pays only $1.26 to $1.36 per ton to the contractor.

It was held unwise, therefore, that the city take over the incinerator plant from the contractor at this time or prior to the expiration of the contract in 1942.

End of Litigation Sought by PWA

PWA Administrator Ickes has asked the Department of Justice to follow up the Supreme Court decision in the Duke Power case by securing dissolution of the temporary injunctions that have been issued against 61 PWA allotments for power purposes.

In each case where an injunction has been given, the private power company has had to put up bond. The government has not yet decided to what extent it will press claims against these bonds.

The Supreme Court decision will act as the controlling precedent in connection with litigation on 61 projects in 23 states with an estimated total construction cost of $146,918,000, for which PWA has allotted $61,226,000 as loans and $38,412,000 as grants.

A list of PWA projects affected by the Supreme Court decision is given on page 88 of this issue.

Parker and Marshall Ford Engineers Reassigned

Parker Dam in California and Marshall Ford Dam of the Colorado River of Texas project near Austin, Tex., have exchanged engineers in a move by the Bureau of Reclamation to put men on the work for which they are best qualified. Ernest A. Moritz, construction engineer at Parker Dam, who has had wide experience in the construction of concrete dams, has been shifted to the position of construction engineer at the Marshall Ford Dam, where pouring of concrete has just started.

Howard P. Bunger, previously construction engineer at Marshall Ford, will take Mr. Moritz' place at Parker Dam. Concreting there is nearly finished and Mr. Bunger's chief duty will be the installation of gates.

Mr. Moritz, a graduate of the University of Wisconsin, joined the Bureau of Reclamation after a number of years in engineering posts on railroads. He has worked on the Yakima project, and the Flathead project.

Mr. Bunger received his education at the University of Colorado, and he also has had railroad experience, as well as some years of work in Mexico on engineering and reclamation assignments. He served in the Denver office of the bureau from 1920 to 1926 and has been at Marshall Ford since 1935.

Minor Flaws Found In Housing Project

Weaknesses are not structural and will not prevent opening project in February

Although a report by a committee of construction experts found that reported defects in Lockefield Gardens, a PWA low-rent housing project in Indianapolis (*ENR*, Dec. 30, 1937, p. 1039), are "not serious" in nature and do not affect the structural safety of the development in any respect, Nathan Straus, head of the U. S. Housing Authority, has ordered that the defective apartments be kept vacant until it has been demonstrated that no hazard will be incurred by occupants. Meanwhile, construction work is being pushed to completion and it is expected that unaffected sections of the project will begin to be occupied in February.

The report, made by J. Earl Ballantyne, of Barr and Lane, Inc.; and John J. Graham and James J. Clifford of Marc Eidlitz & Sons, Inc., stated that they would not hesitate about taking over the development for occupancy at once, despite the existence of some defects, such as leaking walls and spalling concrete.

Chicago project leased

Administrator Straus has signed a lease turning over to the Chicago Housing Authority for operation three federal projects: Jane Addams Homes, Julia C. Lathrop Homes, and Trumbull Clark Homes. The lease runs for a term of two years.

In negotiation for the lease of two projects to the Memphis, Tenn., Housing Authority Mr. Straus set a rent schedule averaging only $4.61 per room per month, one of the lowest rates ever set for a project of this type. It will apply to Lauderdale Courts and Dixie Homes.

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Additional Loan Made To Platte Project

The Platte Valley Public Power & Irrigation District of Nebraska has received a supplemental loan from the PWA of $1,061,000 to permit completion of the Platte Valley project. This additional loan brings to $11,121,000 the amount received from PWA by the project. Previous allotments included a grant of $2,345,000 and a loan of $7,715,000.

Funds for the new allotment were drawn from unallotted and unobligated balances in the PWA revolving fund.

Relief Funds Accounted For

Since July 1, 1932, $15,291,913,000 of emergency relief funds have been made available. At the end of 1937 there remained an unexpended balance of $1,385,244,000, of which $983,926,000 was unobligated. These figures were pointed out in a report which was prepared by the Treasury Department and transmitted to Congress.

As required by law, the report makes a detailed analysis of the disposal of the $8,422,079,000 made available under the relief acts of 1935, 1936, and 1937. This amount includes all the expenditures made for WPA.

A breakdown of the amounts allotted to the various agencies through which the relief funds were distributed is shown in the large table below. The purposes for which the money was used are as follows:

Highways, roads and streets	$1,645,466,743
Public buildings	540,399,598
Housing projects	99,926,621
Public recreational facilities	553,136,024
Conservation work	911,478,713
Electric, water and sewage systems	410,677,347
Transportation facilities	202,362,919
Educational projects	642,912,767
Sewing, canning, gardening, etc.	535,673,774
Rural resettlement and direct relief	345,925,094
Grants to States for relief	922,368,770
Administrative expenses	380,694,947
TOTAL EXPENDITURES	$7,191,023,323

The largest single item for which money was expended was personal services, which took $4,065,680,000. Supplies and materials absorbed $550,594,000.

During the three years covered by the report, more than 171,000,000 checks have passed through the Treasury offices, of which more than 147,000,000 relate to activities of the WPA. The peak of check volume was reached in March, 1936, in which month more than 9,000,000 checks were issued. At present the average is over 4,000,000 checks per month.

ALLOCATIONS OF RELIEF FUNDS, 1935–1937

Organization	Amount	Percentage	Expenditures	Unexpended
Agriculture	$134,057,926	1.6	$122,372,918	$11,685,007
Public roads	506,899,690	6.0	423,433,878	83,465,812
Farm Security Administration	489,869,640	5.8	417,421,179	72,448,461
Corps of Engineers	187,778,008	2.2	141,816,531	45,961,476
Emergency Conservation Works	594,936,258	7.1	592,373,352	2,562,905
Federal Emergency Relief Administration	934,842,359	11.1	933,780,027	1,062,331
Public Works Administration	404,105,896	4.8	347,219,572	56,886,323
Works Progress Administration	4,166,658,598	49.4	3,834,870,866	331,787,732
All other organizations	508,135,019	6.1	377,734,990	130,400,023
Unallocated	494,795,288	5.9	.....	494,795,288
TOTAL APPROPRIATIONS	8,422,078,684	100.0	7,191,023,323	1,231,055,361

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Billion and a Third Manhours From PWA

PWA non-federal projects created 1,337,000,000 man-hours of employment in industry in the four years from July, 1933 to July, 1937. This is in addition to the labor created directly at the site, which totaled 1,415,546,000 man-hours during the period for the entire PWA program, federal and non-federal.

The employment study, conducted by Herman Byer, chief of the Bureau of Labor Statistics, Division of Construction and Public Employment, revealed that material orders placed with private industries for the non-federal program exceeded $1,708,686,000. Specific studies of employment were made in five major industries, revealing employment, including final fabrication, production and transportation, as follows: Steel, 611,000,000; cement, 116,000,000; lumber, 129,000,000; transportation, 114,000,000; and clay products, 44,000,000.

Payrolls directly at the site of PWA projects amounted to $931,242,000, of which $383,831,000 was paid on non-federal projects.

John A. Capp Dies at 67

John Allen Capp, past president of the American Society for Testing Materials and a recognized leader in the field of materials and tests for more than thirty years, died at Schenectady, N. Y., on Jan. 5 following an appendix operation. At the time of his death he was Engineer of Materials for the General Electric Co., in whose service he had spent most of his 45-year career.

A native of Germantown, Pa., and educated at the University of Pennsylvania, Mr. Capp served as draftsman in the Fairmount Machine Co. and in 1892 entered the employ of the General Electric Co. at Lynn, Mass., later going to the company's main plant at Schenectady. Beginning in the testing laboratory he became chief of the laboratory after two years, and later, on establishment of the Works Laboratory, he became its head as Engineer of Materials.

Mr. Capp's interest in materials early led him to become active in the American Society for Testing Materials. He joined the American Section of the International Association for Testing Materials at its organization in 1898, and became one of the founders of the American Society of Materials when the latter succeeded to the work of the American section. His most important contribution to the society's work was made through years of activity as member and chairman of the committee on Copper and Copper Wire, which placed that material on a firm basis of established quality. He served many years on the Steel committee and for a time served as its chairman.

Because of his marked executive ability he played a prominent part in the councils of the society, serving on its executive committee. He was elected president in 1919. During the same period he participated in the formation of the American Engineering Standards Committee, now the American Standards Association, and he continued in that body as A.S.T.M. representative to the time of his death.

Mr. Capp was distinguished by sincerity, integrity, fairness and courage. Equipped with a wide fund of knowledge, he was keen and quick and rarely erred in his judgment of men or circumstances. His friendliness and helpfulness to young men of the profession endeared him to all.

Regular Federal Aid Bill

(*Continued from page 39*)

over federal-aid roads are incorporated in the new bill. It is provided that after two years no project submitted by a state shall be approved unless the Secretary of Agriculture finds that the state has enacted and is enforcing an "adequate uniform code for safety in the operation of motor vehicles, particularly with respect to the licensing of drivers and the operation of such vehicles."

The Secretary of Agriculture is also authorized to adopt a uniform system of highway warning and numbering signs and a uniform system of symbols for indicating the various types of improvement of highways on maps. Use of these markers and symbols without official permission of the Secretary or the state highway department is made punishable by fine.

In introducing his bill, Representative Cartwright revealed that during the special session he had failed to introduce two bills suggested by the administraion that would have carried out the President's recommendation for repeal of the 1938 authorizations.

LABOR NOTES

CHICAGO electricians are carrying out a threat made by their business agents at the time the Chicago Sanitary District awarded the contract for building an incinerator at the Southwest sewage treatment plant to the General Electric Co. At that time (*ENR*, Nov. 18, 1937, p. 810) representatives of the International Brotherhood of Electrical Workers, A.F.L., stated that the union did not recognize General Electric as a bidder in the Chicago district.

Work on the sewage plant has now been halted by a strike of the electrical workers. The men are employed by the Central States Electrical Construction Co., which holds a subcontract from General Electric. The business agent for the local stated that the union felt that the General Electric Co., a manufacturing concern, should not enter the construction field and take work away from local contractors.

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Montreal-New York Canal Found Uneconomic

A deep water canal system connecting Montreal with New York City is not economically justified at the present time, the International Joint Commission, which has been conducting an investigation of the project, reported Jan. 4. The commission requested authority to reopen the inquiry if it was ever decided to proceed with the St. Lawrence water way project.

After an investigation of five alternate routes, the commission found that the least impracticable would be that from Montreal down the St. Lawrence to Sorel, Que., up the Richelieu River to Lake Champlain, and by way of the present canal from Lake Champlain to the Hudson River. The cost of a 27-ft. channel over this route would be $342,203,000.

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Largest Fair Building For Railroad Exhibit

The largest building at the New York World's Fair of 1939 will be devoted to railroad exhibits. It will be an S-shaped structure about 1,400-ft. long, with a 180-ft. dome about eight stories high in the curve of the S at one end of the building. An amphitheatre with 4,000 seats will be placed alongside the central portion of the building. The building itself will include four exhibition halls in addition to the usual lobbies and rest rooms.

CHILDISH PLAYFULNESS

COLLAPSE of this abandoned three-story apartment building in Cincinnati is believed to have been caused by children removing timber bracing for firewood. The building was begun about seven years ago, but was abandoned unfinished.

Windows in an adjoining building were broken by falling debris, and automobiles parked nearby were buried when the building collapsed. No one was injured, since it had been evident for some hours that the building would go.

Toll Cut Increases Traffic On Gate Bridge

Average daily traffic over the Golden Gate Bridge during an eleven day period when the basic toll rate was cut from 50 to 25 (*ENR*, Dec. 30, 1937, p. 1040) cents was 11,924 vehicles as compared to average of 6,031 per day for the preceding 23 days of December. Holiday travel doubtless accounted for part of the increased traffic. However, competing ferries lost about 70 per cent of their traffic to the bridge during the experiment, which was made primarily to determine whether the bridge would regain ferry traffic on a rate parity basis. The reduced rate is said by the district to be far below operating requirements. Normal tolls were resumed Jan. 4.

WASHINGTON HIGHLIGHTS

Special reports by Paul Wooton

ACTING under the new law permitting the federal government to become a party to any suit in which the constitutionality of a law or action is called into question, the U. S. Supreme Court on Jan. 10 notified the Attorney General that he would be permitted to intervene in a pending case involving the validity of an interstate compact, between Colorado and New Mexico, which has been ratified by Congress.

The suit was brought by the La Plata River and Cherry Creek Ditch Co., which is trying to force Colorado authorities to furnish it with water which was contracted for prior to the completion of the compact, and which the state claims is not available under its terms. Colorado courts have upheld the company's contention that the compact deprives it of contractual rights, and is therefore unconstitutional, and this decision will be reviewed by the U. S. Supreme Court.

REP. JOHN J. DEMPSEY of New Mexico has introduced a bill to authorize the construction of a federal reclamation project to furnish water to the Arch Hurley Conservancy District in that state.

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Mexico City to Improve Its Water System

The municipal government of Mexico City plans an expenditure of about $8,300,000 to provide additional water supplies for Mexico City and the federal district. The existing system was designed for a population of about 500,000, whereas the federal district now has a population of about 1,500,000.

It is planned to add about 100,000 gal. per min. to the city's water supply by impounding and bringing to the city water from various streams in the Lerma lagoon district, bringing the city's water supply to about 150,000 g.p.m. Water will be brought to the city through an aqueduct which will include an open channel, an 8½-mile tunnel and a covered channel. Power will be generated at three points on the aqueduct to product a total of about 15,000 hp., part of which will be used for pumping water in the federal district. Work is expected to start early this year.

News continued on page 87

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Unions and Unemployment

Sir: In your editorial "Unions and Employment," *ENR* Dec. 30, p. 1,013, you propose as a test of "real statesmanship" that we agree to downward revision of wage rates for our workers.

The F.A.E.C.T. has developed a program to meet the present unemployment situation that is realistic and based on the actual economic and financial factors involved. First of all, let us state that we do not accept your position that increased wages and salaries serve to speed up layoffs. This position has been refuted on more than one occasion. An analysis of the profits made this year by the large industrial corporations, will show that the small increase in wages given to their workers has in no way hurt their business.

The recent special conference of the F.A.E.C.T. revealed the fact that companies having contracts for a few year's work, have suddenly without warning and without any cause, decided to curtail their work and to lay off their employees.

The F.A.E.C.T., like other C.I.O. unions, is prepared to meet a bona fide situation of a natural curtailment of business by having the work spread with a reduction in hours or in the number of days work in order to maintain the full staff. The federation, however, is not prepared to agree to any such proposal where it is evident that there is no natural need for curtailment, where the condition of the business is such that all the workers can be maintained at their present rates of pay.

On Dec. 3, the federation sent the following instructions to its officers in the field and to its chapters:

"When a layoff is rumored in a plant, elect a committee to see the management to ask for explanation. Take in figures showing the company's profits during 1936 and 1937. Call a meeting of the whole staff, in order to take action on such a committee's report.

"Consider the proposal that the work be distributed in order to maintain the full staff where it is found that the company is legitimately unable to continue its work."

Such a program meets the needs of the technical employees, of business and of the nation. Any other program would be a capitulation to the sixty families of economic royalists who own this country and would be a direct encouragement to them.

MARCEL SCHERER
Organizational Director, Federation of Architects, Engineers, Chemists and Technicians.
New York, Dec. 31, 1937

Wet vs. Dry Dust Control

Sir: The article "New Rock Drill Dust Control" in the Dec. 30 issue unfortunately creates the impression that the solution of the dust problem in rock drilling is by the wet method with ventilation, and that the exhaust system has been a failure and is of no value. Neither part of this impression is correct.

The wet system as described has not been fully developed, but is only in the process of development, still far from perfection. The contention expressed in the article that this type of ventilation (water spray in the effluent air pipe) filters the dust by means of water mixed with the ventilating air is wrong, for it is well known that siliceous dust is insoluble. In passing through the ventilating system, particularly at high velocity, the fine dust particles merely impinge against the baffles or water particles and are carried through the exhaust to be disseminated into the general outside atmosphere.

This fact was illustrated by the original installation of the equipment, wherein the exhaust discharged through a pipe extending several feet above the street decking under the Sixth Ave. elevated line. The dust discharged through the exhaust was not only visible to the naked eye, but was so objectionable that the elevated railroad company engineers requested the installation of baffle louvres at the discharge end of the pipe.

The test results shown in Table I are misleading and incomplete. Tests on the jumbo were not made under actual tunneling conditions, as might be supposed, but took place in a decked-over, wide, cut-and-cover section of subway construction, where the cut was some 35 ft. deep, extending from building line to building line and several hundred feet long—a working chamber of probably a million cu. ft. in volume. Why were the results of the grab samples made of the effluent air not given? Why were the results of tests known to be made on exhaust systems Nov. 19 on the Flinn Corp. section, Nov. 18 on the Carleton Co. section, and those made of four wet drifters and two jackhammers on the same job Oct. 14, all omitted?

The attacks made by the contracting group against the exhaust system are unwarranted. The so-called "idealized" tests made on this type of equipment were conducted by Theodore F. Hatch of the state department of labor, whose qualifications cannot be questioned. Instead of being ideal, these tests were made under extremely severe conditions, seldom encountered in actual construction work. I respectfully dare the proponents of the wet system to submit their apparatus to test under similar conditions.

Efficiency defended

As to efficiency and operating characteristics of the exhaust units, I have never heard of a complaint of this nature from any of the users, which includes some of the contracting group as listed in the article. Trained technicians have not been required. In fact, operation has been entirely successful with unskilled labor. These units can be delivered to the average job—excepting possibly a real tunnel—and set up in ten minutes, ready for operation by anyone after fifteen minutes of instruction. Of course, no mechanical device is 100 per cent fool-proof, but it is not right to charge improper use by workmen as a fault of the machine.

Claims made that extraordinary supervision is necessary to keep the units in operation are absurd. Furthermore, when properly used the exhaust system will not leave a cushion of dust in the hole as stated

by the contractors, nor will the hose clog up with cuttings. Lastly, drill steels are no more apt to stick with dry drilling methods than they are with wet drills.

Realizing that millions of dollars have been spent in South Africa and elsewhere in the past 30 years in the effort to prevent silicosis, is it reasonable to believe that a small group of contractors, even with the aid of a consulting engineer, have been able to develop an adequate dust control system in a few weeks? Is this system infallible and free of possible breakdown, as is charged against exhaust systems?

Wet drilling with ventilation is not the solution of dust control in rock drilling, as has been proved by years of research by high authorities. Nor is it accepted as a final solution in foreign mining centers, rather it is advocated in the absence of something better. In South Africa experiments with air conditioning to relieve the dust hazard recently have been conducted at great cost, though wet drilling with ventilation has been tried there for years. Almost every article published on the subject of rock drill dust control in final conclusion recommends trapping the dust at the source by the exhaust method.

Further proof of the failure of wet drilling to control silicosis comes from the Lake Superior mining district, where a mining company finds from a survey conducted by a prominent research laboratory that, despite long use of wet drilling methods, 48 per cent of the employees have contracted silicosis. Even Mr. Tillson remarks in an article published in *Engineering and Mining Journal* Mar. 4, 1934: "Students of the subject should bear in mind that such small particles as are here considered are readily borne by droplets of water, so that water spraying might increase rather than reduce the hazard present."

Pulmonary diseases

Is the reader to believe that workmen are subject to pneumonia and other pulmonary diseases solely from clothing becoming saturated with perspiration and not from wet drilling? I doubt it. Right now a large mining company in Pennsylvania is interested in the exhaust system, not because of the silicosis hazard, but because the compensation costs covering pulmonary and other diseases resulting from wet drilling are growing tremenduously.

Finally, in experimenting on the job with a different and wholly untried system that recirculates the effluent ventilating air in the heading, it appears that the contracting group is making human guinea pigs of the workmen.

JAMES H. MARKLEY
President, Markley Dust Control, Inc.
New York, Jan. 4, 1938

For Further Research

Sir: I have just read Dr. Rudolfs' valuable article suggesting continued improvement in the methods of sewage treatment, supplemented by research to develop useful byproducts. (*ENR* Dec. 30, 1937, p. 1055). I hope that this article will stimulate interest in research in all parts of the country and thereby hasten the time when such hopes may be realized.

F. E. GIESECKE
Director, Texas Eng'g. Exp. Sta.
College Station, Tex.

Sewage Salvage Appraised

Sir: My answer to Dr. Rudolfs' question, Salvage from Sewage? (*ENR* Dec. 30, 1937 p. 1055) is yes. But further research will be necessary before there will be much increase in the present limited amount of salvage.

Chief obstacle to the general utilization of sewage is the large volume of liquid to be handled to recover a comparatively small quantity of salable byproducts. The most that can be hoped for at present is a reduction in the cost of sewage disposal. The danger is that the increased capital and operating costs will eat up all or more than the income from byproducts.

Except in regions of deficient rainfall the chief hope from salvaging sewage today lies in recovery being made incidental to some essential element in a process of treatment chosen to produce an effluent best suited to meet local conditions. This hope now centers in sludge dewatering to produce a fertilizer base or filler or soil conditioner that can be sold to manufacturers, and with the recovery of digestion gas for use at the treatment plant or in other city works with the surplus, if any, made available for commercial light, heat and power. The possibilities of combining garbage and sewage disposal deserve further exploration.

Recovery of byproducts from industrial wastes, conducted by the industries themselves, will doubtless be extended. Besides lessening the burden on municipal sewage treatment works, both in volume and in trouble caused by the character of the wastes, treatment at industrial plants might sometimes produce effluents that could be discharged into adjacent waters without nuisance, thus reducing the necessary carrying capacities and costs of portions of the city sewerage system.

Many attempts to utilize the fertilizing value of sewage by direct application to land give little hope for salvage in that way. Greater hope comes from the use of sewage primarily for irrigation, with the sewage pretreated to prevent clogging of the soil and putrescence. More latitude in the variety of crops irrigated may be had by disinfection of the sewage. Greatest hope lies in so treating the sewage that it may be conveyed to the irrigation fields in natural stream channels, supplementing dry-weather flow, and resorting to storage when the crop demand is low.

The many disappointing results in past attempts to utilize sewage—and the number would appear greater if proper accounting and other records had been kept—have been due to lack of understanding of fundamentals, either on the part of cities or of central governments that have dictated specific methods, or, and particularly, by promoters of proprietary processes whose object was profit by the use of their process whether or not adaptable to local conditions. The hope of the future lies in scientific research and the adoption of its teachings by cities and by commercial interests. To this end more and better city laboratories and state and college experiment stations are needed. In these days of federal aid, directed so largely to conserving and increasing the fertility of the soil, additional contributions to sewage-utilization research is highly desirable.

M. N. BAKER
Upper Montclair, N. J., Jan. 5, 1938

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JANUARY 13, 1938

AFTER A YEAR OF ACCOMPLISHMENT the art of roadbuilding faces unusual responsibilities as it enters 1938. Quite unexpectedly it is called upon to meet a challenge of extravagant and nonessential performance that has been hurled at it from high places. Its responsibility is to make an aggressive defense of highway improvement. No longer can it take for granted that the essential nature of its work and its efficiency are recognized, else the proposal to abstract road tolls from their intended use and let relief squads drive self-supporting workmen from the roads could never have been advanced. The duty therefore rests upon the roadbuilders of 1938 to carry the facts of highway service and highway construction to the public at large. In order to do this, however, it is necessary that they have precise knowledge at hand. As a central part of that knowledge the record of 1937 has been assembled for the present issue, through the countrywide cooperation of highway engineers. The comprehensive and yet detailed story of roadbuilding activity and scientific development which it presents is offered by *Engineering News-Record* as a contribution to better public service through the roadbuilder's art.

The States Report

OUR FORTY EIGHT STATES through their highway departments, working in close cooperation with the federal road authorities, have carried practical highway science forward in consistent advance during the past year, making an accomplishment that ranks with any in our history. It is important that the public should realize the value of this many-headed planning and creation in providing road transport. The reports from the several states in this issue demonstrate that not only have the states worked energetically and efficiently on the scarcely-begun task of modernizing our inadequate highway transport system, but that their careful study of road service, materials, design and construction has done much to further the art. The relation of road design to local traffic and climate has been worked out more definitely. The utilization of local materials through stabilization and compaction has been made more effective. Perhaps most important, the aim of highway engineers has been raised to the requirements of tomorrow, and because of this reorientation of purpose the risk of early road obsolescence has been diminished. These advances lay a foundation on which we can build securely.

A Clear Course

MUCH OF THE CONFUSION that now envelops questions of river development is known to be due to lack of adequate organizational mechanism, which in turn results mainly from overlap of federal and state jurisdiction. Recent efforts of federal agencies to seize control of rivers are a further complication. The remarkable article of Arthur E. Morgan which we published last week, "A Statute for River Development", points a way out of the difficulty, through enactment of a federal enabling statute to authorize the formation of interstate water-control districts. Such districts would represent primarily the local interests, though the federal government would cooperate. Dr. Morgan's experience in organizing and directing local districts, as well as the success of the district system in dealing with problems of smaller scope, gives the proposal strong claim to consideration. Action on many problems of interstate river utilization is virtually impossible under the present conflict of jurisdictions. In addition the holdup of the New England flood compacts at Washington serves warning on state authorities to attempt no action. It is evident, therefore, that fundamental enabling legislation is required.

Water Zoning

A CONCRETE PROPOSAL toward the solution of a problem nearly fifty years old is contained in a recent suggestion of John C. Page, reclamation commissioner, that land use in the Great Plains be controlled by zoning on the basis of available water. This new type of zoning represents a form of control that runs counter to many rooted instincts, but one that promises in final results to benefit the individual as well as state and nation. Normally it should be possible to work out such a matter through local action alone, but the great dimensions of the present problem appear to make it necessary to invoke also national action. Retiring lands from agriculture and reserving them for grazing use is probably the only feasible way to neutralize the lure of wet years and the resultant stage-setting for drought distress in the following dry years. The case is one in which region-wide plans and regional action are essential. The situation of the Great Plains and of the Red River of the North basin reveal clearly the existence of large

regional problems and justify general support of measures to make early regional action possible.

Construction Costs

WERE IT NOT SO SERIOUS the current situation in Washington with regard to construction costs would be amusing. In the juggling of the wage-hour bill during the closing days of Congress an amendment calling for the payment of prevailing wage rates was put forward; it had the approval of those in the administration who seek to raise labor rates, but it was opposed by those who seek to stimulate house construction, as they feared that payment of prevailing rates would make costs so high as to discourage housebuilding. In the abstract those in power in Washington favor higher costs, but in any particular application they are opposed. Such inconsistency, and more especially the wage-fixing plan, is not conducive to stimulating the upward surge of new construction that the administration seeks. Labor suffers along with everyone else from efforts to establish government wage control. Construction costs must be scaled down to an attractive point if new work is to be inaugurated. When there is no work the prevailing rate of pay is exactly zero!

Protect the Public

LONG-ESTABLISHED PRACTICE requires that when an individual enters into a contract with a public authority he shall give surety for full and prompt performance. It is known by experience that the protection of such suretyship saves the public from frequent loss; without it the contractor may feel justified in abandoning the uncompleted work if it proves unprofitable, in which case the public suffers delay and loss.

From time to time the merits of this tried and tested system are challenged, and it is decried as wasteful expenditure. Insurance of property against fire is all right, it is said, and every prudent individual will take out insurance on his life; but insurance against contract losses and defaults is extravagant. On this view it is sometimes proposed that in lieu of surety a large part of the progress payments earned on the contract be retained to build up a protective guarantee fund. This proposal has indeed been adopted in some instances, and (according to reports) with no harmful results. It is therefore in order to inquire just what the surety system does for the public and why it has remained a basic element of public contract procedure.

Competition of widest possible range by qualified contractors is recognized as the essence of good policy in public contracting. The basis of such competition is that all bidders be treated alike, and that no conditions or burdens be imposed that will bear with different weight on two equally qualified bidders. A contract system under which the contractor must also be the banker for the work is known to impose such discriminating burdens. Contractors are not bankers, but retention of contract payments in substantial amount does make the contractor assume a banker role and thereby militates against full and free competition.

If the public interest in free competition speaks for a surety system that has uniform application to all qualified bidders, the right of the public to be protected against the hazards of contract performance, as well as maintenance of good public business morals speaks to the same effect. The cost of claims, the delay resulting from interruption and re-award of the work, and the protection of material and labor suppliers, are reasons why a public agency should avoid making the public its own guarantor of contract performance, and should insist that this function be carried out by competent independent agencies.

Every reason of sound public business conduct, in brief, argues for the established system of bonded surety for contract performance. It is fundamental to sound contract relations that the diverse but cooperating interests of the several parties be kept distinct and free from confusion or overlap. It is as unsound to have the owner guarantee a contractor's performance as it is for the contractor to guarantee the engineer's plans or the wisdom of the owner's investment. And the public, which in the case of a public contract is the real owner, is entitled as much to protection against official error and favoritism—which only too easily might be involved in a system of public guarantee of contract performance—as it is entitled to protection against the contractor's failure.

In summary, contract insurance is inherently a function outside those of the parties to the contract. In its very nature, moreover, it is a private and not a public function; the spreading of risks that is the essence of sound insurance can hardly be achieved by an agency engaged in a limited volume and variety of work. Nor can it be urged that money is saved by discarding the surety system, for statistical loss ratios will be alike under either control with the same spread of risk; if anything, the independent surety system lowers the cost by reducing the risk through its closer supervision.

Cost reasons hardly enter the case therefore. The controlling consideration is that the public interest on every point supports the established system of surety protection of public contracts and argues against specious attempts to shift the responsibility of protection to the shoulders of the public for which the work is performed.

Roadbuilding 1937-1938

MORE AND BETTER ROADS will be built in 1938. That is the meaning of the data contributed by roadbuilding officials and engineers all over the country to this issue of *Engineering News-Record.*

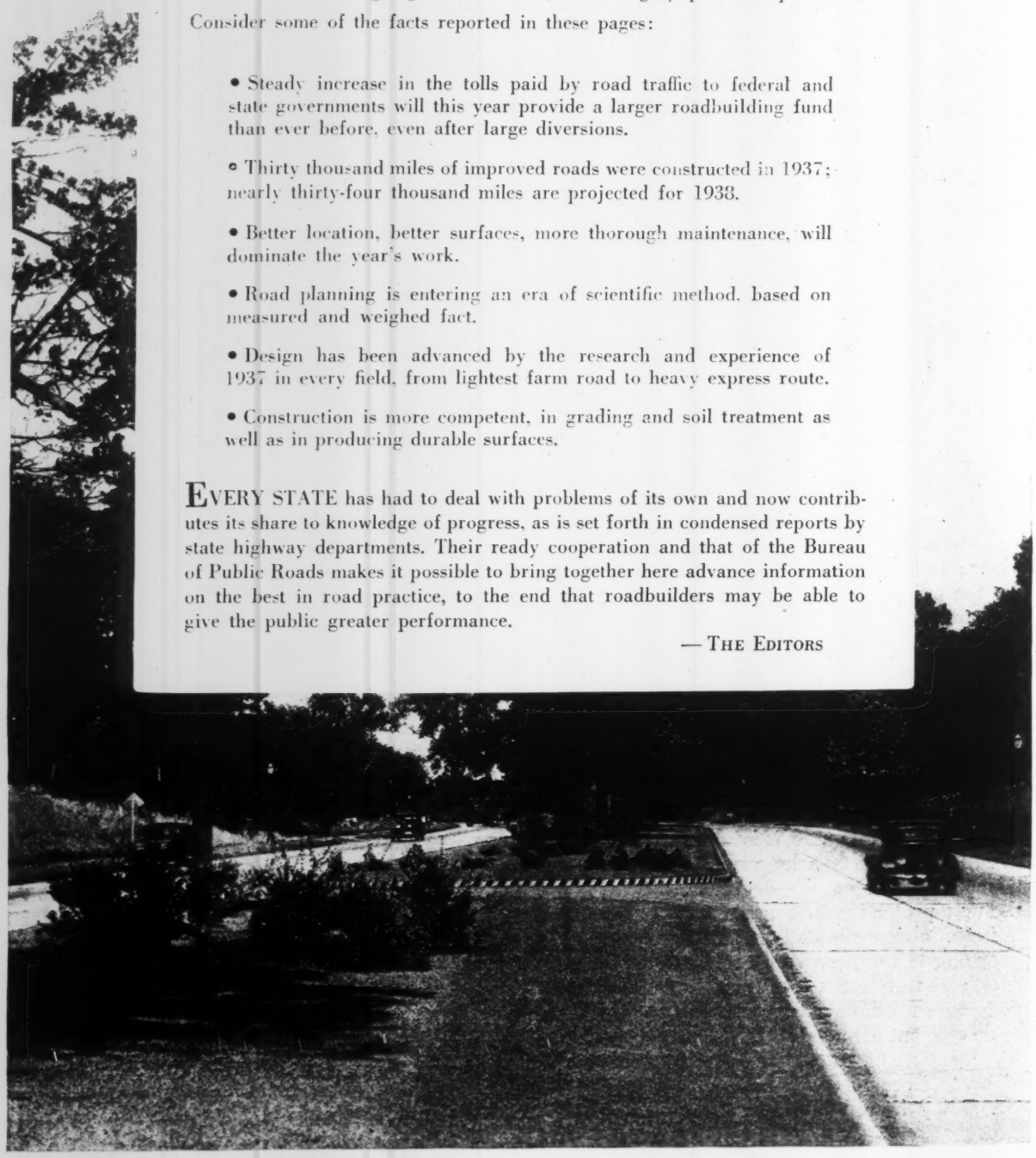
Construction budgets show a total 12½ per cent ahead of last year's roadbuilding. Moreover, a vigorous art goes into the new season equipped with more exact knowledge, greater skill and more highly perfected procedure.

Consider some of the facts reported in these pages:

- Steady increase in the tolls paid by road traffic to federal and state governments will this year provide a larger roadbuilding fund than ever before, even after large diversions.
- Thirty thousand miles of improved roads were constructed in 1937; nearly thirty-four thousand miles are projected for 1938.
- Better location, better surfaces, more thorough maintenance, will dominate the year's work.
- Road planning is entering an era of scientific method, based on measured and weighed fact.
- Design has been advanced by the research and experience of 1937 in every field, from lightest farm road to heavy express route.
- Construction is more competent, in grading and soil treatment as well as in producing durable surfaces.

EVERY STATE has had to deal with problems of its own and now contributes its share to knowledge of progress, as is set forth in condensed reports by state highway departments. Their ready cooperation and that of the Bureau of Public Roads makes it possible to bring together here advance information on the best in road practice, to the end that roadbuilders may be able to give the public greater performance.

— THE EDITORS



What's Ahead in Roadbuilding

One of the three top years of all time in roadbuilding is coming; following 11 per cent drop in 1937, 43 states budget 12½ per cent gain for 1938

STATE expenditures for highway construction in 1938 will be 12½ per cent greater than in 1937, and for maintenance they will be 2½ per cent greater. This prediction is based on a careful field survey by *Engineering News-Record* which includes the new budgets for 43 states. How significant this gain is in relation to previous state highway activity is illustrated by the accompanying chart. It puts 1938 into the exclusive company of 1930 and 1936, the only two preceding years that topped $1,100,000,000.

And 1937 was a good year; it can be called a recession year only because it failed by 11 per cent to maintain the record pace set by 1936. In spite of this drop it looks like the fourth-highest year on record. With total expenditures estimated at $1,060,000,000, 1937 volume had been exceeded in previous years only by $1,091,000,000 in 1931, by $1,131,000,000 in 1936 and by $1,140,000,000 in 1930.

The indicated gain of 1938 is not uniformly distributed, as 19 states are responsible for a faster pace and only 6 plan to continue expenditures at the 1937 rates. The leading pace setters in per cent of gain over 1937 are Alabama, Connecticut, Illinois, Indiana, Louisiana, Maryland, Mississippi, Nebraska, New Jersey, New York, and Pennsylvania.

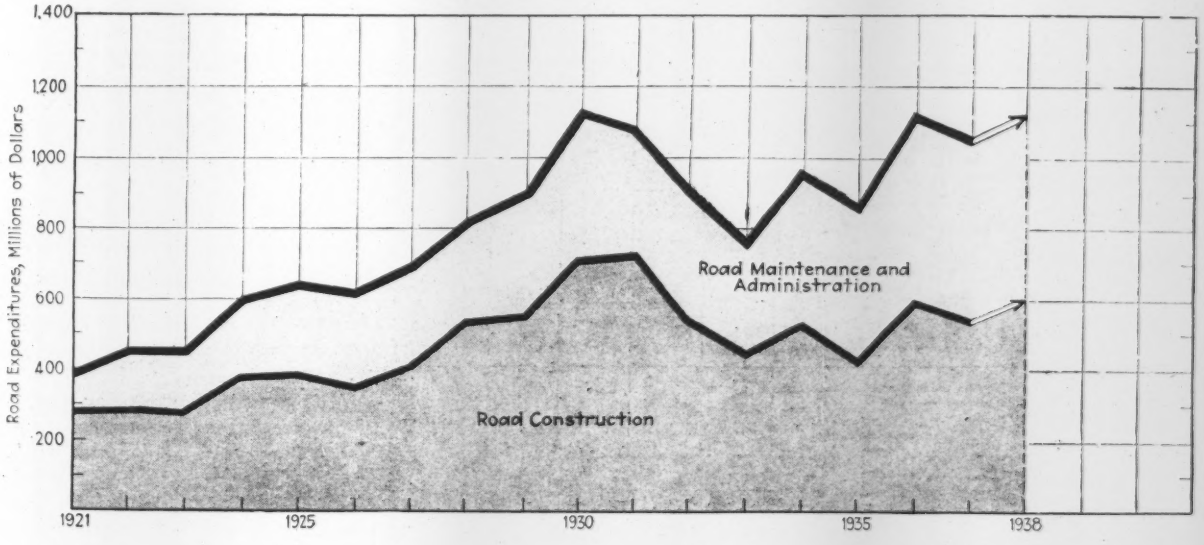
Only a part of the states have the 1938 expenditures planned in any detail. From her 25 million budget, California has assigned 2.9 millions to 40 feeder roads, 10.2 millions to 50 low-type surfacing projects, 8 millions to 40 high-type surfacing jobs, 1.9 millions to 11 grade crossing eliminations, 2 millions to 36 bridges, and in addition plans one 7-mile parkway.

The state of Illinois allots 3.3 millions to low-type, 17.5 millions to high-type surfacing, 4.8 millions to grade-crossing elimination, and bridges, mostly on the high-type system. Iowa plans 200 mi. of low-type surfacing on stabilized base and 200 mi. of high-type surfacing.

Out of her 12.4 millions, Kansas assigns 1.3 millions to secondary roads, 1.3 millions to grade separation, and distributes the balance to her regular program of improvement. Louisiana assigns 3.1 millions to secondary roads, $500,000 to low type, 10.7 millions toward completing her high-type program, $800,000 to grade crossing elimination and 1.1 millions to bridges.

Missouri schedules 2.1 millions for secondary roads, $200,000 for 119 mi. of soil stabilization, $100,000 for 30 mi. of gravel, $700,000 for 125 mi. of low-cost bituminous, 3.6 millions for 110 mi. of concrete, 1.1 millions for 21 mi. of parkways, 1.5 millions for grade cros-ing elimination and $700,000 for bridges with 5.6 millions added for grading for the foregoing and 1.1 million assigned to 37 mi. of other grading.

Texas distributes her 24.5 million dollar budget to secondary roads, 3.2 millions; soil stabilization, $25,000; low-type surfacing, 8 millions; high type, 7 millions; roadside landscaping, $200,000, grade crossing elimination, 3.8 millions and bridges 2.3 millions.



State highway expenditures for 1937 and highway budgets for 1938 compared with previous years since 1920.

Trends in Types

An outstanding characteristic of roadbuilding in 1937 is the upward trend in high-type surfaces and a decline in the use of surfaces of low type

THE most striking characteristic of state highway construction in 1937 is the 19 per cent increase in high-type surfacing. Almost 6,250 miles of high-type surface were built last year, the largest production in this class since 1934. High-type makes up 22 per cent of the total mileage built in 1937 compared with 15.1 per cent in 1936. These figures are based on unofficial preliminary data assembled by *Engineering News-Record* for this issue, and summarized in the accompanying table and chart.

Low-type surfacing, down 25 per cent from 1936, has been stimulated since 1933 first by the transfer of secondary mileage to five state systems followed in 1934 by secondary systems in nine more states, and then by provisions of the Emergency Relief Act and subsequently of the Hayden-Cartwright Act which give federal financial grants to states for secondary road construction.

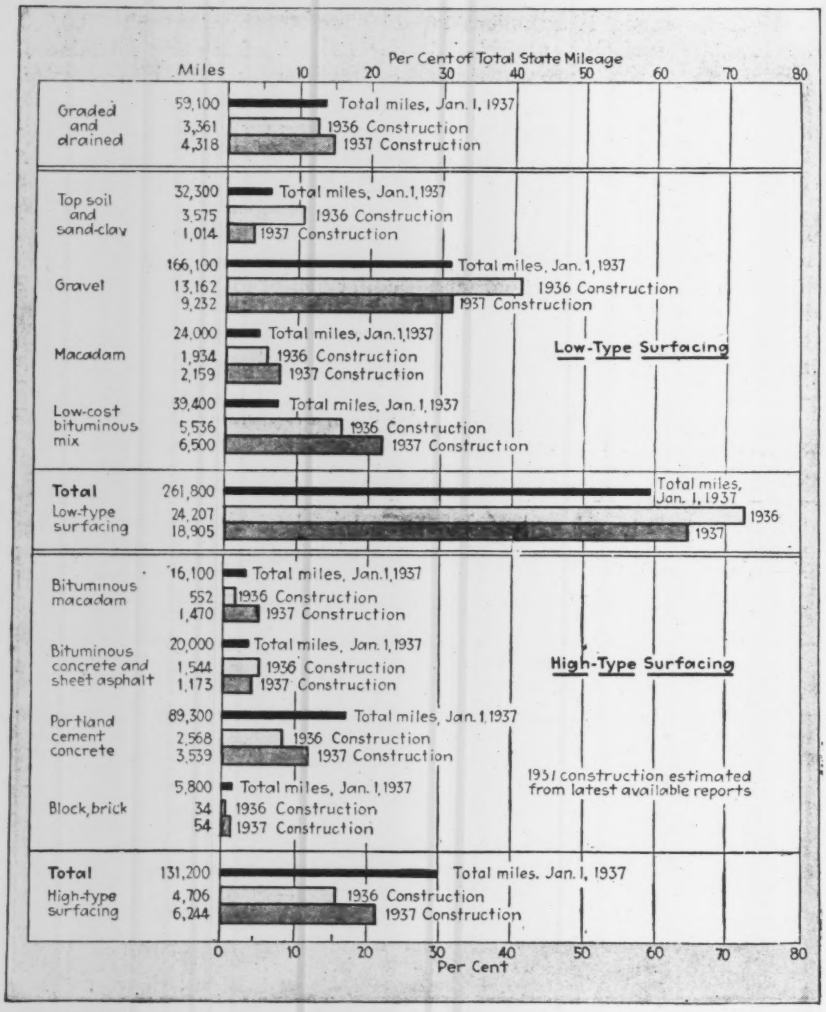


Fig. 1. Totals and percentages of different types of state-road improvement to Jan. 1, 1937, and for the years 1936 and 1937.

In 1937, with normal federal aid restored, construction of high-type surfacing regains the spot light. Bituminous macadam accounts for 5 per cent of the 1937 mileage, and an increase of 180 per cent over this class of mileage built in 1936. Bituminous concrete and sheet asphalt accounts for 4 per cent of the 1937 mileage, a 30 per cent decrease in mileage from 1936. Portland cement concrete accounts for 12 per cent of the 1937 mileage, and shows a 25 per cent gain in mileage over 1936. Brick and block mileage shows a 10 per cent decline from 1936.

Bituminous macadam

Half of the bituminous macadam gain is due to the 406 miles built in South Carolina, 94 per cent of the high-type mileage built in that state. Texas with 379 mi. is mainly responsible for the other half of the gain while New York and Oklahoma also show gains. Ohio shows a drop in this type of road. In bituminous concrete or sheet asphalt, Ohio reports a large gain; Texas, Indiana, Georgia, New York and Oklahoma, show declines.

Half of the portland cement concrete gain is due to 425 mi built in Mississippi, a gain of 378 mi. over 1936. The rest of the increase is accounted for by gains of 100 mi. in Iowa, 62 mi. in Illinois, 100 mi. in Kentucky, 91 mi. in Pennsylvania, 71 mi. in New York and 136 mi. in Wisconsin.

The principal low-type mileage loss is in treated and untreated gravel, 40 per cent and 44 per cent, respectively. Low-cost bituminous surfacing shows a 21.9 per cent gain, and treated macadam a 3.9 per cent gain over 1936.

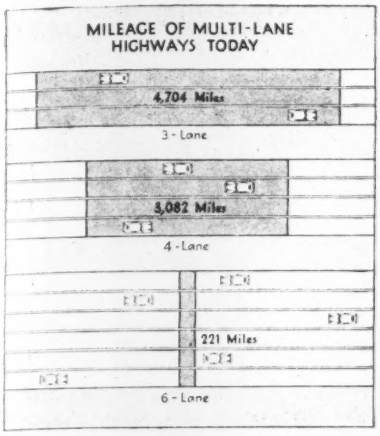


Fig. 2. **Pavements with more than two traffic lanes are still a small part of the total mileage.**

Thirty states built low-cost bituminous roads in 1937 compared with 35 in 1936. Alabama, Minnesota, New York, Oklahoma, South Carolina, Tennessee dropped out of this column. Colorado came into it with 716 mi. New Mexico is the next highest with 619 mi. of which 123 mi. has rock asphalt topping. Nebraska is third with 477 mi., then follow Missouri, 460 mi., Washington, 445 mi., Texas, 410 mi. and Idaho, 326 mi.

Treated macadam roads were built by ten states and untreated macadam by nine. Virginia heads the treated macadam with 310 mi., Georgia reports 305 mi., West Virginia, 172 mi., Oregon, 140 mi. Kentucky heads the untreated macadam ranks with 405 mi., Oregon follows with 250 mi., Indiana with 118 mi. and Illinois with 108 mi.

Treated gravel mileage was built by 24 states headed by Minnesota, 726 mi., California, 438 mi., Alabama, 351 mi., Kansas, 338 mi. Untreated gravel roads were built by 31 states, headed by Minnesota, 803 mi., Georgia, 586 mi., South Dakota, 575 mi., Colorado, 570 mi., Missouri, 502 mi., North Dakota, 382 mi., and Kansas, 375 mi.

Treated topsoil mileage is reported in nine states led by North Carolina with 220 mi., Alabama with 198 mi. and California with 128 mi. Untreated topsoil mileage is reported in six states topped by North Carolina with 50 mi.

The trend in types of mileage built in 1936 and 1937, compared with the types existing Jan. 1, 1937, is illustrated in Fig. 1. This shows distinctly the emphasis on low-type construction in 1936 and the shift back into high-type construction in 1937. It illustrates, too, the relative mileage in the principal classes of state highway within each of the three periods.

In 1937 for the first time, statistics show the mileage of 3-lane, 4-lane and 6-lane roads, compared in Fig. 2. These multi-lane mileage totals, up to July 1937, are reported by the American Association of State Highway Officials with estimates to allow for the second half of 1937 added by *Engineering News-Record*. The important trend toward separating traffic going in opposite directions merits statistical study, but reports are not complete enough now to include the mileage of that type.

Estimated rural highway mileage in the United States slightly exceeds 3,000,000. Of this amount, 517,700 miles or 17¼ per cent is in state systems under state control. Of this 517,700 miles, 340,200 or 65½ per cent constitutes the primary state highway system, and 177,500 miles, or 34½ per cent, the secondary state system, which is confined at the present time to 14 states.

Miles Built in 1937 reported to Engineering News-Record correspondents in 48 state capitals

(Partly estimated and subject to modification when final annual reports are out)

	Miles
Graded and drained	4,318
Top soil and sand clay	1,014
Gravel	9,291
Macadam	2,159
Low cost bituminous mix	6,509
Total low type surfacing	18,905
Bituminous macadam	1,470
Bitum. Conc. and Sheet Asphalt	1,173
Portland cement concrete	3,539
Block, brick	54
Cotton fabric	8
Total high type surfacing	6,244

Fig. 3. **The universal trend in four-lane construction is to separate lanes for opposing traffic by a parting strip.**

Keynotes From the States

Forty state highway departments announce planning, design and construction practices that will rule roadbuilding in 1938

FORTY-EIGHT autonomous agencies build the public roads. What are they planning and doing that determines the roadbuilding of 1938? The answers are given in the roster of state highway departments that follows. In these statements directly from the pens of state highway department heads and technicians are found the mind and purpose of highway development in the year ahead.

It is unmistakable as one reads these virile statements that boundaries and regions impose no limits on progressive highway thinking; it is as evident in the regions where population is sparse and traffic is small as it is where industries crowd each other for room and transport fights for a place on the highways.

But the outstanding value of the two-score direct quotations is that they set forth the plan and structural form that the roads of 1938 will take. And neither plan nor form will be what it has been. Main roads are definitely removed from the order of design that tolerated four-rod rights of way, three-foot shoulders, steep ditch and cut-and-fill slopes, hidden intersections and short-sight distances. Such design exists but the faults are recognized and the new order of design countenances none of them. Road design today definitely points its purposes to a minimum 100-ft. right of way, to 1000-ft. sight distances, to 11-ft. traffic lanes, to separated travel ways on four-lane roads, to rolling cross-profiles, to planted roadsides and to general design for 60-100-mile travel speeds. These are notable in the statements on this and following pages.

And the refinement of road design brings new obligations to construction; it is forced to set finer requirements for materials and workmanship. Old tolerances in subgrade and surface profile, in surfacing mixture design, in pavement thickness and joint placement, in fill placement and compaction, in shoulder and slope finish and in transition of line and grade are made obsolete by the more enlightened requirements.

No such complete personal expression of what highways will be built and how they are to be built has ever before been given by working roadbuilders as is recorded in the statements that follow.

Construction in the mountains shows the same regard for details of design that is found in less difficult country.

REPORTS OF STATES

Massachusetts multi-lanes

Road construction during the past year in Massachusetts has very definitely emphasized the safety factor. More miles of the superhighway type have been built than ever before; these are roads with three or four travel lanes in each direction, and a center plot of grass about 20 ft. wide between the two roadways. Eight projects of this type have been completed, and others are under way.

Several new features of design have been built into these roads, each of which adds to the safety of the highway compared with the cross-section of earlier divided roadways; in part these new features are sloping white curbs, wider center plots, wider lanes, crowded roadways with a complete drainage system at the inner edges as well as at the outer edges to permit the use of the center plot for snow

(Continued in opposite column)

MODERN ROADBUILDING PRACTICE . . . IN SIX ARTICLES

Grading Operations Multiplied

by J. L. HARRISON
Senior Highway Engineer, Bureau of Public Roads, Washington, D. C.

Changes in design of highway line and profiles and in methods of fill construction bring heavier and more exacting grading tasks

ONE OF THE most obvious changes that is taking place in highway construction is the steady increase in the volume of grading per mile of highway. The tendency in design is definitely toward better alignment and grades to increase the safety with which traffic moves. The effort to reach this objective is also resulting in wider subgrades, flatter embankment slopes and lighter side ditches. The increased amount of excavation that these changes are creating is requiring the use of larger grading outfits and heavier grading equipment. This effect is not particularly apparent as viewed over a single year, but as viewed in retrospect over the past five or ten years it is quite obvious. The trend is definitely in the direction of heavier work, which will require still heavier units—both excavating units and hauling units.

Besides the change in excavating and in hauling units other changes not quite so apparent are resulting. Thus, the tendency to eliminate deep side ditches and to avoid side borrow is to reduce the relative amount of material that is moved laterally over short distances into embankments and correspondingly to increase the relative amount moved longitudinally from the cuts. This means less casting and more hauling, with some, though rather an intangible, corresponding alteration of the average cost of handling grading work.

The 1 on 1½ slopes formerly used both for back slopes in cuts and for side slopes on embankments have been readily handled by all customary types of grading equipment—usually without the assistance of hand labor except in the final clean-up. In particular, the 1 on 1½ side slope on fills represented about the position in which material arranged itself as dumped. The use of flatter side slopes requires some extra work, as material does not arrange itself naturally on these flatter slopes.

The present tendency in grade design is to eliminate sharp angles and to substitute for these a warped or rolled transition at the top of cut slopes and from the shoulders onto the side slopes of fills. The practice of warping the slopes at the ends of both cuts and fills also is appearing. These changes have as their objective a general softening of lines, which improves the appearance of the completed highway. From the construction standpoint, however, they increase the amount of hand

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storage. A 12-ft. lane along the center plot is provided for high speed. One or more 11-ft lanes are for slower moving travel, and a 10-ft. lane is for parking. In most cases sidewalks are included as a part of the design. Highway grade separations of the full cloverleaf design are provided at all important cross roads.

The department has started the construction of three major bridges over the Connecticut River, ranging in cost from $650,000 to $1,400,000 each.

The sidewalk construction program, which consisted of about 500 mi. of bituminous concrete, portland cement, concrete, gravel, tar and stone dust sidewalks, was started about two years ago and was practically completed in 1937.—*G. H. Delano, Chief Engineer, Massachusetts Department of Public Works, Boston.*

Connecticut landscaping

The legislature in 1937 passed an act authorizing the highway commissioner to lay out a highway described as the Wilbur Cross Highway, running in a generally northeasterly direction from the Stratford-Milford town line to the Connecticut-Massachusetts line. No particular change was made in road design except plans now provide for 11-ft. instead of 10-ft. lanes.

During the past year the Bureau of Roadside Development has completed 24 landscape projects. These include picnic or parking areas. At the present time the department has approximately 150 of such areas.—*John A. Macdonald, State Highway Commissioner, Hartford.*

Small bridges in Maine

As a result of the severe March floods of a year and a half ago, the commission, in cooperation with the municipalities, the WPA and the Bureau of Public Roads, undertook the replacement of 30 bridges estimated to cost about $2,000,000 (*ENR*, July 8, 1937). Funds were furnished by municipalities and the WPA and the engineering, including surveys, design and inspection was done by the state highway department. Twenty-six of these projects were placed under contract in 1936 for construction in 1937; four projects were placed under contract during 1937.—*L. D. Burrows, Chief Engineer, State Highway Commission, Augusta.*

Vermont's new road

The legislature of 1937 provided for laying out a central route the length of the state from the Massachusetts line to Canada.—*H. E. Sargent, Commissioner of Highways, Montpelier.*

Rhode Island changes

During the past year several changes have been made in specifications. Base-course specifications in bituminous macadam construction include the application of water after the sand filler has been applied dry in several applications to the crushed

Continued on p. 56

work that is required, and will continue to do so until construction equipment and construction practices have been so perfected that contractors are able to accomplish mechanically the work these details involve. In short, they add to the complexity and cost of grading.

There is a definite tendency toward the more general use of subgrade stabilization. In the field of highway grading this reflects itself in an increasing demand that subgrades be built in layers and that these layers be thoroughly compacted. This is forcing contractors to give constantly increasing attention to the proper equipment of the dump. Present indications all point to considerably more rigid requirements in this field during the next few years.

Already some states are requiring that the moisture content of the material placed in fills must be held within rather definite limits and that, if material as taken from the cuts does not contain a sufficient amount of moisture, water must be added and thoroughly mixed into the fill material before the layer is compacted. This prospect that the correction of the water content will become a generally-accepted practice suggests that grading contractors must shortly be far better equipped with water tanks and mixing equipment than they have been in the past. It also suggests that in planning high rates of production greatly increased attention to the proper tooling of the dump and to the distribution of material over it will have to be given if customary production schedules are to be maintained.

In the past the disposition of material on the dump seldom has interfered with production. Present indications are that in the very near future such detailed attention will be given to the way material is placed in the dump that the facilities for the treatment and the compaction of material on the dump will be of major importance in maintaining profitable rates of production.

The work of subgrade stabilization is in its infancy, but the need for it is now pretty generally recognized by highway engineers. There is accordingly an increasing demand not only for the routine treatment of the raw subgrade in a more scientific manner, but also for a more intensive special treatment of the top of the subgrade which will further insure stability. Beside the selection of materials for this portion of the fill with such temporary storage and rehandling as their use is coming to involve, the perfection of stabilization will not infrequently involve the improvement of these materials by the admixture of aggregates.

The application of scientific knowledge in the development of better subgrades is closely allied to the development of better bases. The old practice of laying a single selected material—gravel, sand-clay, broken stone, etc.—as a base for a bituminous mat or for other types of surface is giving place to the selection of two or more materials which must then be mixed on the road to give a more satisfactory combination of materials—one more certain to retain its stability after placing.

This tendency constantly to work for an improvement in the stability of bases is definitely affecting construction practices, particularly those which involve the manipulation in the field of sand-clay and gravel bases and is likely to continue to make the construction of such bases more complex. Here again the obvious effect is the increased manipulation that is involved and the increased amount of equipment that must be used where it is required, both of which add to the cost at which the work is performed. The intangible but more important aspect is that, unless the operations that stabilization involve are properly mechanized, general production is likely to be retarded by delays in the stabilization work. Until this work is better understood and the equipment required in handling it is improved and more completely standardized, its effect on the general progress of the work is likely to continue to be an important matter to those who contract to handle it.

The insistent demand for better rideability is developing a field for blade-grader equipment that is capable of more readily accurate work.

The increasing trend of drainage design toward the use of underdrains is another factor being added to the complexity and cost of grading.

REPORTS OF STATES —*Continued*

stone or gravel in this 5½-in. course.

The design of four-lane roads for rural areas has abandoned the typical 40-ft. concrete section, with curbs and sidewalks; at three locations this year a dual-pavement with two 10-ft. or 11-ft. strips of concrete separated by 25 ft. of bituminous macadam surface has been designed. Outside of the concrete lanes it is expected to continue the bituminous macadam for another 18 or 24 in. to protect the shoulders immediately adjacent to the concrete lanes.

One of the chief costs in shoulder maintenance is the renewal of surface treatments alongside two-lane concrete roads. In recent designs the gravel foundations have been carried 10 ft. in several instances and a 2-in. pre-mixed surface has been applied to this area using a mix of fine gravel and MC-3 or possibly RC-3 cutback asphalt.—*John C. Keily, Chief Division of Roads and Bridges, Providence.*

New Hampshire subgrades

In New Hampshire road design for 1937 continued to develop along the lines outlined by soil or foundation surveys. Instead of a uniform design for base courses the foundation of all new roads has been varied to meet the foundation conditions encountered in the field.

The placing of fills in 12-in. layers with thorough compaction of each layer has been carried out. Before the placement of base courses the subgrade has been fine graded within exacting limits. The construction of low types of road surfaces has been carried out with the precision comparable to the construction of higher-type road pavements. The development of graders in particular and all road equipment in general has enabled the contractor to work to much closer limits than ever before.

The bridge construction during 1937 was much more extensive than normal, due to the flood of the previous year. (*ENR*, July 8 and 15, 1937). Many of the designs of minor bridge replacements in the flood program were governed by the speed of construction rather than strict economy. The larger and more important structures on trunk lines and over the larger rivers were given careful study. Particular attention was given to foundations, flood clearances, elimination of piers and other obstructions to flood waters. In some of the projects it was possible to develop designs that were not only more economical but also attractive.

Investigations indicate that methods have been found of preventing the so-called chloride scale on concrete pavements and on two projects now planned two of these methods are to be used; one consists of a linseed-oil surface treatment and the other is the use of a natural cement admixture in the concrete.

Absolute viscosity studies show the tremendous advantages to be gained by the adoption of specifications using absolute units and studies of manipulation methods show that in surface treatment work with road tars much heavier consistency

Better Surfacing Ahead

A symposium of advances in constructing asphalt, brick, concrete, tar and stabilized soil surfaces by experts in the several fields

SINCE THE ADVENT of automotive transport, surfacing has been the most absorbing study of the highway engineer, and in surfacing he has most nearly perfected the practices of design and construction. The following review of progress in 1937, made by recognized authorities, is a record of trends and changes that are considered significant.

Surface Treatment—In the general procedure of surface treatments there are few recent changes except in regard to conditioning of the surface prior to treatment. The use of primers has increased greatly and they are selected with greater care to ensure the degree of viscosity best suited to the natural surface conditions. There is a trend toward the use of pretreated aggregates for surface treatment, particularly on nonbituminous surfaces such as concrete and brick and block pavements. Another variation is the rehabilitation of old cracked hot-mix surfaces; here surface treatment both fills the cracks and relieves the old surface. But with all the advance in surface treatments, there is a growing tendency to substitute road-mix construction particularly for original work on sandy-gravel aggregates and traffic-bound macadam. Better stabilization and seal coating are obtained because of the greater depth to which the asphalt is carried.

Road Mixing—Mixing the asphalt and the aggregates on the road continues to be the most popular practice in general and was followed on large mileages in 1937. The dense-grade aggregate is still preferred in the west and the macadam-type aggregate in the east. There have been some notable developments in road-mix equipment, particularly in the pugmill attachment to the multiple-blade grader. This permits very rapid mixing and only one pass of the mixer. There is a feeling among engineers that still further developments in road-mixing equipment are possible.

As in plant-mix construction, there is the growing realization that different aggregates take coatings of bituminous materials at different rates and that it is not always practicable to make a mix that can be immediately placed and rolled, particularly if there is moisture present. In general, certain aggregates—trap rocks, limestone rocks, many granites and slag—have a high affinity for asphalt, and may be spread and coated in one passage of equipment. With certain siliceous rocks it may be desirable to have a longer curing period before spreading and compacting. For this reason in certain parts of the country it is still felt to be better practice to windrow the mix to one side of the road after mixing has been completed and to allow it to cure in this windrow for some days.

Traveling plants have steadily increased in number and have been particularly valuable where the aggregate was already largely in place on the road and could be readily collected in a windrow. Any small deficiencies in the way of particular aggregate sizes may be made up by adding them to the top of this wind-

materials may be used than has been generally supposed.—*F. E. Everett, State Highway Commissioner, Concord.*

New York cement study

For a number of years New York has been conducting a rather exhaustive research into the desirable properties of cement. This is a natural outgrowth of some investigations of the properties of sand for concrete pavement, both subjects being intimately related to the scaling of concrete pavement. This work generally has included laboratory research and a coordination of field experience and observation with indicated laboratory trends. There has finally been evolved and now is in use a specification for portland cement, a specification for natural cement, and a blended cement specification for cement concrete pavement.

Design has also called for increasing consideration. It is now commonly recognized that safety largely determines a choice of sight distance, alignment, grade, banking of curves, etc. These elements, in turn, are largely determined by speed of vehicles. What maximum speed or group of speeds should be fixed by legislation or rule and regulation is now a problem. Generally speaking, however, New York state designs are for speeds of 55 or 60 mi. per hour where topography permits. Most of this state is predominantly rolling or rugged and the following general limits have been adopted as the basis of design:

On primary routes the minimum sight distance shall be 1,000 ft. (greater if practicable) on three-lane pavements and on two-lane pavements which may later be widened to three lanes. If the attainment of this minimum is not economically feasible, an additional lane shall be built. On secondary routes and primary routes in mountainous sections, a minimum sight distance of 600 ft. is required.

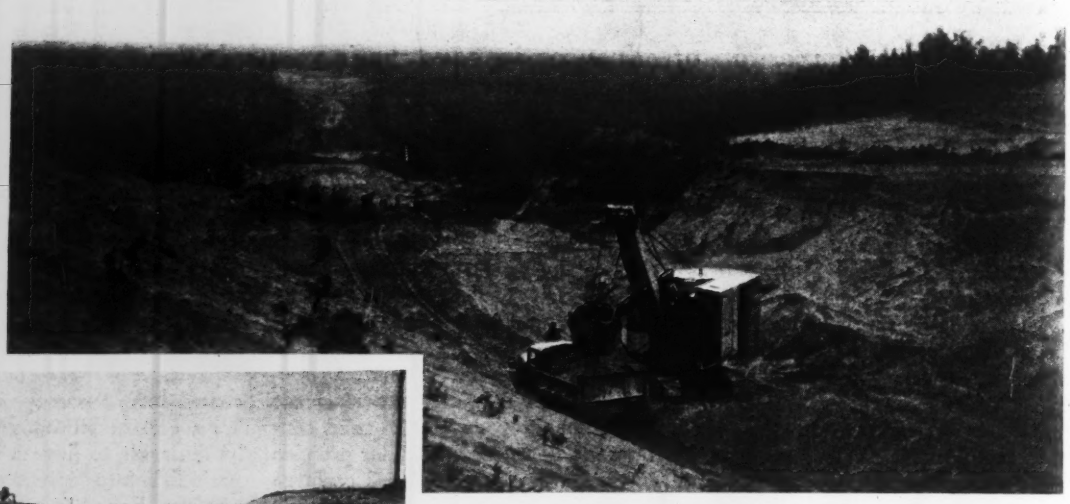
It is the endeavor to keep to a maximum grade of 5 per cent on primary routes and 7 per cent on secondary routes, but an insistent effort is made to obtain the least possible grade consistent with a reasonable expenditure. On primary routes a radius of curve of 2,500 ft. with a minimum of 1,500 ft. is standard, and on secondary routes a radius of 1,500 ft. with a minimum of 1,000 ft. The maximum banking of curves is about ⅞ in. per foot of width, diminishing to ⅛ in. on curves of 1,500-ft. radius. Maximum banking is determined by the ability of vehicles to negotiate curves in winter time, with snow and ice, rather than by a theoretical determination under ideal conditions. Progress in roadside improvements, generally simple planting, is rapid.—*E. C. Lawton, Assistant Commissioner of Highways, New York State, Albany.*

Pennsylvania maintenance

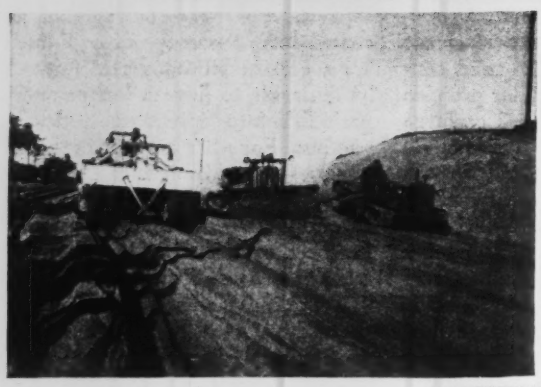
With a 40,000 mi. highway system under its jurisdiction, the department is continuing its policy within the funds available, of keeping a high standard of maintenance on all our highway system, and of spending construction funds in such manner as will best serve the interest of the state as a

Continued on p. 60.

CURRENT CONSTRUCTION EQUIPMENT

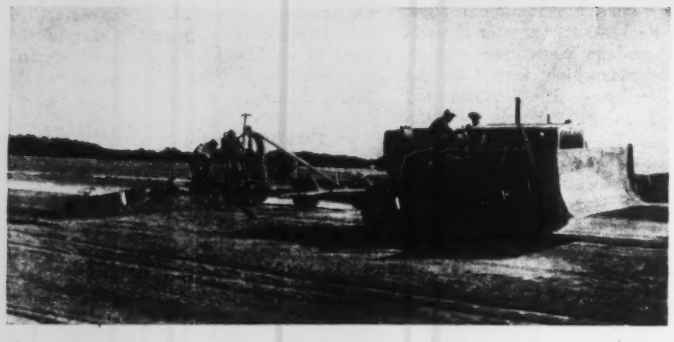


THE POWER SHOVEL and truck for rough roadgrading are growing constantly to larger sizes as design calls for increased earthmoving.



AN INCREASING use of carryall scrapers and tractor bulldozers is taking place on heavy grading.

SPECIAL base construction is calling for equipment like the clay and gravel mixing plant shown on a 1937 grading job.



WIDE SHOULDERS on flat slopes are calling for extensions to blade grader equipment that permit finishing in a single trip.

row, after which the traveling plant picks up the aggregate, coats it and deposits it in back of the machine.

Cold-Laid Plant Mix—There has been a large increase in the use of cold-laid mixes due to the improvement in mixing plants; by volume production they have also greatly reduced the costs of premixed materials. The resurfacing of old pavements by rather thin cold-laid plant mixtures has received a great impetus from this lower cost range, and with the availability of mechanical spreading devices it has become possible to place satisfactory resurfacing with as little as 100 lb. per sq.yd. This produces 1 in. thickness and is somewhat less than has been found desirable by hand methods. Rates of as low as 70 lb. per sq.yd. have been placed. In heavier surfacing it is held desirable to spread the surfacing in two or more layers, and, whereas this used to be a fairly expensive hand operation, it now adds very little to the cost per ton of spreading when mechanical equipment is used, regardless of whether one, two or three layers are spread for any given thickness.

Hot Mix — Hot-mix construction has been greatly stimulated for the same reasons set forth for cold-plant mix, viz, the remarkable development of the automatic asphalt plant. In general, asphaltic concrete is increasing at a more rapid rate than sheet asphalt due to the somewhat less critical control required, the stability imparted to such mixtures by the coarse particles, the greater ease of spreading with mechanical equipment and the lesser quantity of asphalt that is required. The cost of asphaltic concrete has dropped almost in direct proportion to the development of plant and spreading equipment.

B. E. GRAY
Chief Highway Engineer, Asphalt Institute, New York, N. Y.

Brick surfaces

The recent standards of thin bedding courses on accurately finished bases and the use of a non-bonding wash for removing surplus joint filler have been supplemented by a new method of rolling on boards. Rolling on boards originated in Richmond, Va., and is meeting with increasing favor elsewhere. It was required on the Lincoln Tunnel pavement in New York City. It has the

Broad highways take motorists to such scenes as this.

advantage of permitting the use of heavier rollers such as most contractors have on hand for sheet asphalt construction. The brick are uniformly embedded vertically with the minimum disturbance laterally. The joint lines remain straight, which is desirable from the standpoint of appearance.

In December, 1936, the Ohio Highway Department completed a section of brick pavement in which the brick were laid longitudinally—that is with the 8½-in. dimension parallel with the curbs. Contemplated advantages include smoother riding, reduction in traffic noise, spanning of base cracks lengthwise, a reduction in breaking of brick for transverse closures, economy in labor of laying because of unlimited length of rows, and the elimination of special wedge-shaped sections on curves. The project completed in 1936 was 1.35 mi. long, 20 ft. wide over-all, 3-in. vertical-fiber lug brick on a concrete base, 9-in. integral curbs, standard asphalt filler. An extension of this project for 1.5 mi. using non-exuding filler was begun in 1937 and will be completed in 1938.

Reinforced brick masonry in which steel rods are embedded in the mortar joints has been used to a considerable extent in recent years in building construction. In June 1931 a reinforced brick pavement slab was installed in the driveway entrance to the plant of a paving brick company in Illinois. Based on the success of this experiment an additional test section 38 ft. wide by 75 ft. long was installed on West Grand Ave. in Springfield, Ill. in September, 1937. In place of standard paving brick in basketweave pattern, large vitrified units 3½x8x8 in. were used. They were laid by hand in checkerboard pattern, properly spaced, and reinforcing rods were placed in two directions in the cement grouted joints. The Ohio highway department and the National Paving Brick Association are planning another test installation in Ohio. A base course of the stabilized type will be used under some of the sections. This type of pavement will not require curbs or headers on the sides and it is estimated that it will be less expensive than the usual design. However, it should now be considered as having only an experimental status.

GEO. F. SCHLESINGER
Engineer Director, National Paving Brick Association, Washington, D. C.

Concrete surfaces

The method of laying concrete pavement has not changed greatly during 1937 nor has the equipment used in laying it. Several states and other roadbuilding authorities have changed their specifications to effect an increased use of cotton mats for curing. The desire of engineers for a closer control of the gradation of the coarse concrete has brought about further use of two sizes of coarse aggregate which are handled and measured separately.

There has been an increase in the use of moisture control and compaction to insure maximum stability and uniformity of subgrade support. The Proctor method of determining the optimum moisture content (Fundamental Principles of Soil Compaction, by R. R. Proctor, *Engineering News-Record*, Aug. 31, Sept. 7, 21 and 28, 1933) is rapidly gaining favor in the construction of embankments and also in the stabilization of subgrades.

In addition to the work being done on the design of joints many types of holders have been developed, the purpose of which is to insure that the joint material and the load transfer device remain in the proper position during the placing and finishing operation. Some of these have resulted in better joint construction but need is felt for further improvement and for more economical types and methods than have yet been presented.

Vibration as a method of producing better concrete or concrete of

equal quality at lower costs, continued to receive some attention of engineers and equipment manufacturers in experimental projects. Interest in its possibilities was furthered by the publication of the favorable results of tests on vibrated concrete by the U. S. Bureau of Public Roads. (The Effect of Vibration on the Strength and Uniformity of Pavement Concrete, *Public Roads*, April, 1937).

In the field of construction equipment a number of new types of machinery came into more general use. An increase in the use of bulk cement has been accompanied by the development of new equipment for handling and automatic weighing. A mechanical longitudinal "bull" float was put into commercial production during the past year. It is claimed that this device not only produced a better riding surface but also aids in maintaining the correct crown and cross-section during the finishing operations.

While dual drum mixers were introduced by one manufacturer several years ago, two other manufacturers during the year added a large dual drum (each drum having a rated capacity of 34 cu.ft.) machine to their lines for the first time. The type of machine was designed for use under conditions where it was desired to increase mixer production. Two standard pavers have frequently been operated in tandem or in parallel to accomplish the same resulting increased production of concrete.

WM. M. KINNEY
General Manager, Portland Cement Association, Chicago, Ill.

Tar Surfaces

Tar, like other bitumens, has continued in wide use for surface treatment, for road-mix construction and for premix surfacing. A survey of development in 1937 indicates the following trends:

In the cold-lay plant or tar premix the trend has been toward the addition of more fine aggregate and filler. More rigid specifications are called for in reference to mixing plants to obtain better control of the mix. The trend has also been toward the use of mechanical spreaders and finishers, which better control the smoothness of the finished surface. In many cases certain spreaders and finishing machines are allowed to operate without forms, whereas in other cases it is specified that the finishing machine must operate on steel forms.

In addition to closely controlled plant mixes there has been a trend toward the use of less closely controlled mixes to supplant the road mix. Many of the methods employed have been rather crude and offer no better control over the proportioning of tar and aggregate than does the road mix. In some cases portable plants have been set up at some central point for making the mix.

The Durfee power shovel method has increased in use for mixing bank and pit run gravel and tar. From one to three shovels are used, depending on the size of the project. In this method the shovel digs into the face of the gravel bank, dropping the gravel in a pile on the ground. The tar is applied under pressure at a uniform rate through a manifold equipped with nozzles as the shovel keeps building up a larger pile of gravel at a uniform rate so that the required proportions of tar and gravel are added to the pile. Following this operation, the shovel is used to mix the tar and gravel by combing through the pile and moving it over to a new location, from where it is loaded into trucks and hauled to the job.

A. R. TAYLOR
Consulting Engineer, Tar and Chemical Division, Koppers Co., Pittsburgh, Pa.

Stabilized soil roads

Consideration of stabilized soil construction calls first for definition. There are two general procedures that practice classes as stabilization: (1) Providing the soil with coarse and fine material of the proportions and character required to produce stability and possibly supplementing this by adding chemicals that attract moisture, and (2) incorporating water insoluble binder in fine-grained or poorly-graded soils, compacting the mixture and surfacing this base with a seal or wearing course. Two different construction processes are

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REPORTS OF STATES —*Continued*

whole in modernizing and widening main highway routes and extending improvements on the secondary system.—SAMUEL W. MARSHALL, *Chief Engineer, State Highway Department, Harrisburg.*

Delaware reconstruction

Plans are under way for the improvement of traffic facilities and reconstruction of some of the older highways on the more heavily traveled sections in the northern part of the state. Especial attention has also been given to low-cost construction on secondary roads. There are some 1,000 mi. of earth roads under the jurisdiction of the state highway department. These are being steadily improved by grading, drainage and soil stabilization. Plans are also being made for the widening and reconstruction of several of the older sections of the main trunk system. A new bypass has been completed, avoiding the heart of the business district of the city of Wilmington and the heavy grades on U. S. 13 at present between Wilmington and the Pennsylvania line.—*W. W. Mack, Chief Engineer State Highway Department, Dover.*

North Carolina improvement

More attention is being paid to right of way, which heretofore has been 60 ft. We are now establishing rights of way of 100, 120 and 130 ft. on the more important highly travelled routes. Many of the hard surface roads built in the early twenties were 16 ft. wide. These are being widened to 20 or 22 ft. as rapidly as possible. We are also endeavoring to widen as many miles of our 18-ft. pavements to 22 ft. as funds permit. The standard section of pavement being used mostly is the 8-, 6-, 8-in section, and on the roads carrying the heaviest traffic a 9-7-9 in. section has been adopted.

Many bridges built in the early days of the Commission had a roadway width of 17 and 18 ft. These are being widened as rapidly as possible to a width of at least 4 ft. greater than the roadway width. We now have under construction a bridge across Albemarle Sound, the length of which is about 3½ mi. This is the longest bridge job ever undertaken in this state, and will serve to connect the counties lying north and south of Albemarle Sound.—*W. Vance Baise, State Highway Engineer, Raleigh.*

Maryland's new boulevard

The commission has adopted the policy of securing rights of way of sufficient width to care for future traffic needs. As an example, several sections of the new Baltimore-Annapolis boulevard have been completed or are under construction as a dual highway. Rights of way for the less heavily traveled sections are 150 ft. wide, and grading for a dual highway is under way, but one 20-ft. traffic lane only is being

required and two different types of binding agents are used, generally deliquescent salts (calcium or sodium chloride) for the first procedure and cementitious material (bitumen or hydraulic cement) for the second.

Progress in 1937 has been improvement in practice based on continuing experimentation. Primarily the advance has been more-general and more-exact laboratory and field study of soil character before deciding on procedure. Trials have been made of more types of binding agents, particularly asphalts. Methods of construction as mixing on the road surface, traveling plant mixing and suboiling have been given further comparative study. Comment on soil stabilization by technicians of the principal methods used follows:

Asphalt—In general, the addition of asphaltic material to a soil accomplishes something quite different from merely cementing the particles together. When the proper grade of asphaltic material is employed (according to the particular soil conditions), the actual characteristics of the soil are changed, particularly by bringing about a rearrangement of the particles or densification, so that capillary action is reduced and the soil remains almost completely waterproof. The amount of asphaltic material that is required will vary according to the particle size and the character of the particle, and in general this amount is reduced as the particle sizes above 200-mesh become substantial in quantity.

It usually follows therefore, that a soil may be economically first modified through the admixture of granular particles, and under certain climatic and traffic conditions this may be all that is required to produce a condition of year-round stability. Where severe moisture and frost conditions prevail the further addition of chemical or bituminous materials usually becomes economical. The character of the added aggregates also has a definite influence in giving stability.

In any method of stabilization the surface is vulnerable to surface moisture even though complete resistance to capillary action has been obtained. This partly is due to the fact of slight imperfections in mixing operations so that under the abrasive action of traffic weak areas rapidly ravel. However, more important is the kneading and softening action of traffic on the wetted surface. It is therefore fundamental that any stabilized soil, no matter what the process, should be given a bituminous seal coat to prevent the entrance of surface water.

B. E. GRAY
Chief Highway Engineer, Asphalt Institute, New York, N. Y.

Cement—Three years of intensive research and field work on soil-cement mixtures has just been completed, the past year being devoted to rounding out the details of the basic principles. It has been demonstrated that the compaction of a soil-cement mixture to uniform, maximum density at optimum moisture, with sufficient cement incorporated for stability and durability, will produce a roadway at low cost capable of carrying secondary road successfully. Research work now in progress on treatment methods for highly unstable soils holds promise of economic results. It is now possible to determine economical treatment methods for most soils commonly occurring on roadways in the United States, and ultimately all soil types will be studied.

Experience to date shows that full laboratory testing must precede construction to insure satisfactory results. Soils are diverse in character even though they may have the same general appearance. Soil-cement construction is not fool-proof and may give unsatisfactory results to the uninformed. Therefore it is wise to proceed cautiously in this new construction field.

WM. M. KINNEY
General Manager, Portland Cement Association, Chicago, Ill.

Sodium Chloride (Salt)—In the field of base stabilization several radical departures have been made. In Indiana, where it had been decided to apply blacktop within a 30-day period, the mix has been changed to reduce the plastic index of finished mix and quantity of clay. About 10 per cent of clay, having a

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constructed.—*Nathan L. Smith, Chief Engineer, Maryland Roads Commission, Baltimore.*

Virginia design revision

The aim is to provide paved surfaces of adequate width for the volume of traffic existing or shortly anticipated, so that there is almost constant revision of design, stepping up two-lane pavements to three-lane pavements and three-lane pavements to four-lane pavements providing, in addition, increased safety.

Advantage has been taken of new development in steel sections and the experience of past years to produce bridge designs of greater economy and beauty. The adoption of a continuous beam design in long spans, formerly taken care of with through trusses, has been a forward step and results in a type of bridge which if future conditions warrant can be widened without interruption of traffic and without sacrifice of existing construction, other than the curbs and hand rails which are of minor cost in construction.

Virginia has a large mileage of bituminous macadam roads on the primary system, and the regular maintenance on these roads has called for a periodic bituminous treatment. Due to the development of traffic volume, such maintenance operations create an inconvenience to the traveling public, and to avoid this a plan has been adopted of placing on these roads a light surface course of plant-mixed material. During the past season a large mileage of old concrete roads was smoothed up by plant-mixed surface in some cases, and in others by mixed-in-place surface.—*C. S. Mullen, Chief Engineer, Virginia Department of Highways, Richmond.*

South Carolina contracts

In 1937, 115 construction contracts were awarded for work estimated to cost $9,934,000. Work on 126 of the contracts let or to be let in 1937, or before, was not to be completed Jan. 1. The uncompleted portions of three of these contracts represent $7,000,000 to be paid to contractors and others in 1938 on account of the work. New construction scheduled for the two-year period ending June 30, 1939, and which has not yet been let to contract includes road and bridge projects estimated to cost $12,000,000. Substantially all of these projects will be let to contract by Dec. 31, 1938.—*J. S. Williamson, State Highway Engineer, Columbia.*

Tennessee maintenance

From 1,500 to 2,000 men are employed by the department of highways and public works of the state of Tennessee in the maintenance operations of some 7,816 mi. of highways. The isolated nature of the work required and the hazards presented has led to a safety program by the department's Division of Safety. Briefly the methods employed are as follows: (a) Constant use of a camera; (b) a system

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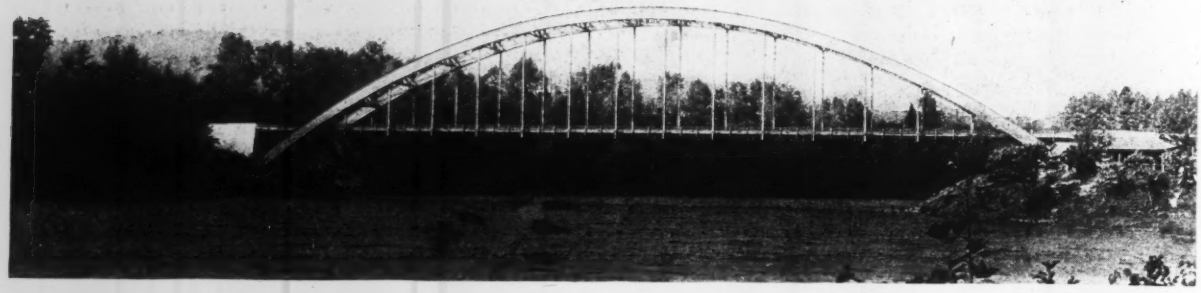
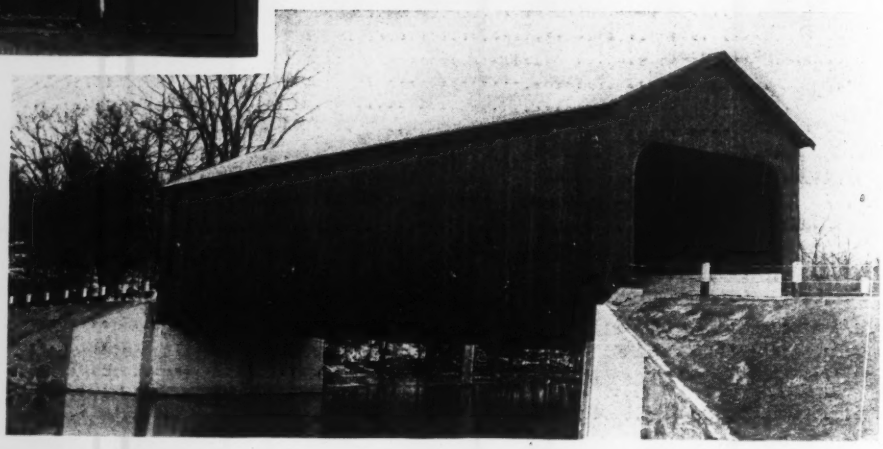
BRIDGES OF TODAY



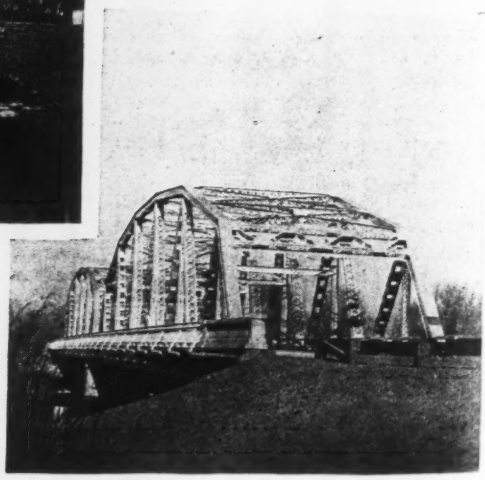
BORN OF THE RUINS left by the New England floods of 1937, this arch replaces an old suspension bridge across the Connecticut River at Brattleboro, Vermont.

SIGHTLINESS and economy have given bridge design a strong trend toward continuous girders as represented by the above highway structure in Maine.



TRADITIONS of an older bridgebuilding era are preserved in this New Hampshire wooden covered bridge constructed in 1937.

REVAMPED, this masonry structure of the stage-coach transportation era in New York State is now carrying motor busses and fast automobiles.



STEEL BRIDGE MODERNITY in every respect is represented at right by this Idaho bridge crossing the Snake River at Blackfoot.

plastic index of 12, has been added to well graded aggregates, giving a finished mix with plastic index of 5 or less.

The contractors handling the work this year decided upon a concrete mixing plant as the best and fastest method of getting the material properly mixed. Regular weight batching bins were used for aggregates, and the clay was wheeled across an "over and under" platform scale to get correct quantities. The salt, as a brine of varying concentration, was then added through the regular water tank on the mixer.

By the use of a salt dissolver, it was possible to produce up to 500 gal. of concentrated brine per hour. To control the moisture content in the finished mix, the brine was placed in storage tanks so that concentration would be varied as the per cent of moisture in the aggregates varied. The total quantity of moisture was to be 8 per cent, or, more exactly, to fulfill the requirements of optimum-moisture control.

It was possible to turn out a batch a minute; quantities up to 1250 tons of mixture were produced daily. No difficulty was experienced in getting material out of mixers, or in sticking or coating of the interiors of the mixers with clay. The finished mix was dumped into trucks, and, being in plastic condition, the mix received maximum compaction due to vibration in transit, which made it possible to spread the material through spreader boxes to the full thickness desired and in one layer. By waiting until the surface was dry enough to roll with a five- or ten-ton roller, the maximum compaction was easily obtained.

Some test cores taken from these roads show densities of from 146 to 149 lb. per cu.ft., while those taken from sections laid in two layers and separately compacted, as well as a section on which a sheepsfoot roller had been used, showed weights of 143 to 145 lb. per cu.ft. since these jobs were designed particularly for use as a base, it was specified that there be no surface variation greater than 1/4 in. in ten feet. By use of a sprinkler wagon, a 30-ft. maintenance drag, and a roller, traveling as a unit, it was possible to fulfill this condition satisfactorily.

Washtenaw and Ingham counties in Michigan have experimented by adding salt to pit-run gravel, without the addition of any clay to aid compaction, so that blacktop might be applied the same year. The roads have gone down hard and tight in a period of six weeks or less, even when laid in one layer of gravel, 8 in. thick and with no rolling other than that given by traffic.

Experiments are now being conducted to find the possibilities of (1) eliminating specified percentages of crushed material as of no advantage in salt-stabilization, which depends on bonding action rather than keying of materials; (2) using stationary drum mixers to reduce equipment costs and speed up quantity production, and (3) applying the clay as an emulsion rather than dry, with the idea that it will facilitate operation in wet weather and eliminate cost of screening and pulverizing.

S. J. DUNCAN
Morton Salt Co., Chicago, Ill.

Tar—During 1937 considerable base stabilization has been done with tar. In most cases 5 to 8-in. stabilized bases have been constructed by scarifying and breaking up the soil into fine particles and mixing them first with water and then tar, and compacting the mix with a sheepsfoot roller. From 1 to 2 1/2 gal. of tar, grade RT–4 has proved ample to stabilize most soils, and the cost of this type of work has ranged from 38c. to 55c. per square yard, including a light tack coat of tar over the stabilized base. It is recommended that this type of base construction be topped with some type of wearing surface, such as a surface treatment, road mix or premix. In many cases a surface treatment is sufficient for the wearing course. This type of surface has the advantage of being inexpensive, and can be topped with heavier wearing surface later.

A. R. TAYLOR
Consulting Engineer, Tar and Chemical Division, Koppers Co., Pittsburgh, Pa.

REPORTS OF STATES —*Continued*

of driver's and foreman's grade cards; (c) a safety rule book; (d) first-aid classes; (e) safety committees; (f) Red Cross flag trophies, and (g) a booby prize (consisting of one billy goat).—*O. F. Goetz, Tennessee State Highway Engineer, Nashville.*

Relocation in Arkansas

Highway surveys in 1937 embraced major relocations on entirely new alignment, and resurveys of previously graded and graveled roads for proposed surfacing projects. In contemplation of a high type of construction, all the major relocation surveys were made with the utmost consideration for easy horizontal curvature, adequate sight distance, longer transitions and railroad grade crossing elimination.

Design in 1937 includes crown widened to 32 and 34 ft., shoulder slopes flattened to 1 on 4, 5 and 6, and back slopes flattened to on 3 and 4 with small-size ditches. Surfacing widths have been increased generally to a minimum of 20 ft. The trend has been toward a full-crown-width gravel or stone base course on a crowned subgrade for asphalt surfaces to provide and stimulate drainage of the subgrade.

Standard design has been generally improved by lengthening the transition distance from 170 ft. to 255 ft. for the superelevation and widening of horizontal curves. Grades have been flattened and vertical curvature lengthened to increase sight distance. An important advance has been the development of complete specifications for placing signs for traffic control.—*W. W. Zass, Chief Engineer, Arkansas Highway Commission, Little Rock.*

Louisiana bridge work

Highway activity in 1937 is signalized chiefly by the bridge work. The principal work placed under construction during the year was the bridge over the Mississippi just above Baton Rouge. This is a joint railway-highway bridge designed by the state highway bridge department and checked and approved by the engineers of the Bureau of Public Roads. This bridge carries one railway track and two 20-ft. roadways cantilevered on the outside of the trusses. It is a continuous cantilever structure with five spans consisting of two suspended spans, two anchor arms and one anchor span. The vertical clearance is 65 ft. above high water and the horizontal clearances are 490, 848, 650, 848, and 490 ft. It is expected that the bridge will be completed in about two years. *Harry B. Henderlite, State Highway Engineer, Baton Rouge.*

Mississippi construction

The year's operations were characterized by continuation of heavy construction begun in 1936. (*ENR* March 4, 1937). On Sept. 28, 1937 the highway department had placed under contract a total of 770 mi. of grading and drainage, including smaller bridges, upon which no pavement has been

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This Year's Road Materials

A survey of the field of roadbuilding materials discloses widespread new methods of application and definite improvement in variety and quality

INCREASED KNOWLEDGE of materials and improved methods of using them continued in 1937. As in research, objectives are not perceived and attained in any one year so that a review of new and better materials is a review of trends that have continued and made progress. These can be summarized only: the circumstantial evidence in proof would fill many issues of *Engineering News-Record*. Condensed even to terseness the summary brings to engineers a record of service by manufacturers and producers that has absorbing interest. Their technologists are lending a powerful hand to the better service of highway transport in years to come.

No new roadbuilding materials came into common use in 1937. Asphalt, brick, concrete and tar; chemical stabilizers, crushed stone, gravel and the natural soils, as for years past, continued to be the elements of road construction.

But this does not mean that there was no progress.

Every material named was in 1937 of better quality or its qualifications became better known or it was used in a better way.

The story of improvement is a long one of many details and space limits its telling to a general summary.

Let us glance at it; in all the broad range of materials of construction, few are being so intensively improved in quality and service as are materials for roadbuilding.

Asphalt mixtures

In asphalts the most notable recent development is the rapidly growing use of asphalt cement cutback with a kerosene type of distillate. By the use of these cutbacks it is possible to employ densely graded or dusty aggregates formerly difficult to coat, and to a degree to displace moisture on aggregates by reason of certain qualities possessed by kerosene. This development has effected a marked improvement in surface treatment, road-mix practice and cold-laid plant-mix practice.

Also recently much attention has been directed to the characteristics of aggregates and their behavior in bituminous mixtures. The former methods of measurement by size and shape do not give the complete answer, and new measurements in respect to physical, chemical and electrical reactions are providing much closer control in obtaining mixtures which become pavements with long and durable lives.

In fact improved control of asphalt mixtures represents the essential advance in their recent development. Take for example plant-mix materials, either hot or cold. There has been a large increase in their

REPORTS OF STATES —*Continued*

constructed, at an estimated cost of $12,000,000. In addition 435 mi. of grading and drainage with pavement, including smaller bridges, has been awarded involving an expenditure of about $14,600,000. The above totals do not include 4 mi. of major bridge projects estimated to cost $1,900,000 which have been placed under contract. Also contracts have been awarded on 335 mi. of pavement at a contract-estimate cost of about $7,400,000.

The above figures approximate $36,000,000 now under contract or completed on the new program. There has been expended $1,900,000 as of Sept. 1, 1937 for items chargeable against the PWA docket; namely, supplies, right of way, blue printing, surveys, detours, etc. There is remaining in the program $4,250,000 yet to be placed under contract and when these funds are expended the Department will have completed 1232 mi. of grading and drainage and 956 mi. of pavement.—*L. A. Harris, Chief Engineer, Mississippi Highway Department, Jackson.*

Alabama's base course study

The major portion of the mileage of low-cost surfacing built prior to 1935 had not proven successful, and an intensive study of soil structure under the surfacing failures was undertaken. From the study it was definitely determined that the failures almost without exception are and were due to the unstable character of the graded-soil mixture found in the base course. Research and observation also revealed that the adverse effects of climatic variations, including the spring breakup, can be overcome by the careful grading of base-course materials and the proper design and construction of the base course. The department has found a thin, flexible surface on a stable base course of sufficient thickness to carry the traffic loads to be the most logical and economical design for the varied soil and climatic conditions that must be met.

The program of cooperative highway construction with the Works Progress Administration and the counties, known as the three-way plan (*ENR* April 16, 1936) has been much curtailed over 1936 due to the limitation of the operations of WPA. However, this work proved so successful and popular that a similar program of state and county cooperative construction known as the two-way plan followed and has greatly increased.—*H. H. Houk, Chief Engineer Alabama Highway Department, Montgomery.*

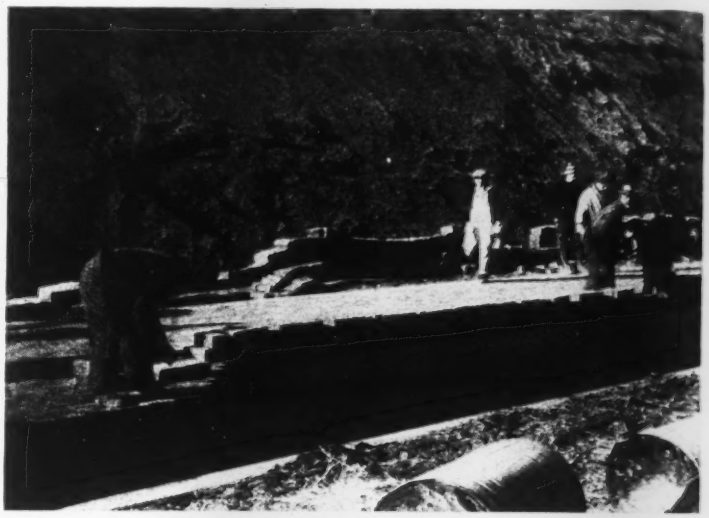
Texas

The following 1938 federal aid programs are now being placed under contract. The regular federal aid program, totaling $15,915,220, includes the following types of work:

	Miles
Grading and small drainage structures:	
New work	303
New work including placing of select material	35
Reconstruct present grade and drainage structures	6
Total	344

use due to better-controlled production. This is essentially a mechanized process. (*ENR*, July 5, 1937). Aggregates are fed to the drier in the proper proportions; the drier is automatically controlled by pyrometers that maintain temperatures within narrow limits; the screening devices and bins are arranged to secure exact sizing; the weighing of aggregate, asphalt and other ingredients is mechanically performed, and with heat control in the way of insulation and other protection batch after batch is identical. To assure this, laboratory tests are constantly checking every ingredient and the product.

Similarly traveling plants for road mix are furnishing better-controlled asphalt mixtures. Using old surface material scarified and windrowed, any deficiency in particular sizes is made up by adding new material to the windrow, after which the traveling plant picks up the windrowed material, mixes it with asphalt and deposits it on the road.



In general all asphalt mixtures approached closer in 1937 to the precision of control long familiar in the production of sheet asphalt. The improved uses of these mixtures are reviewed in another section of this roadbuilding issue.

B. E. GRAY
Chief Highway Engineer, Asphalt Institute, New York, N. Y.

Brick

Brick paving materials include the brick units, the joint filler and the bedding material which cushions the brick slab on its foundation. These are the only items considered here; foundations, whether concrete or other materials, are considered elsewhere, as are improved uses of brick in paving.

Brick Units — The development in the brick unit in 1937 has been closer adherence to the use of brick having a wire-cut wearing surface and end and end lugs, known as vertical-fiber lug brick; to standard sizes; and to greater progress in deaired brick manufacture. The number of standard sizes is now four, as approved in 1937 by the brick committee of the Division of Simplified Practice of the National Bureau of Standards.

The year saw most paving brick plants equipped with machinery for evacuating the air from the mixed clay or shale during the process of manufacture. Deairing with proper methods, it has been found, will produce a brick of greater strength and density and improved regularity of shape, but glassy structure causing brittleness is still to be guarded against and accurate control in manufacture is necessary to obtain the full advantages of the process. The Columbus research bureau of the National

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Gravel, caliche, and all other base course	423
Asphalt surface	
Preservation treatment	29
Permanent surface	423
Total	452
Concrete pavement	152
Grand total highway mileage	1,373
Total bridges	12

The 1938 secondary program, totaling $3,183,044, is composed of the following types of work:

Type	Miles
Grading and small drainage structures	143.0
Grading, small drainage structures and base	199.8
Base course	111.8
Hard surfacing	86.9
Bridges, number	4
	541.5
Less projects added after program sumission	28.3
Program as submitted to bureau	513.2

The 1938 grade crossing program, totaling $2,724,825 is made up as follows:

	No. of Projects	Cost
Construction of new grade separation	12	$1,434,000
Reconstruction of present grade separation	6	482,000
Relocation of highway to eliminate grade crossings	25.4 miles	503,000
Relocation of railroad to eliminate grade crossings	2	80,000
State highway planning survey	..	40,872
Unassigned balance	..	184,953
Total		$2,724,825

The only legislation passed of major importance to this department during the last fiscal year was a bill authorizing the state highway department to carry compensation insurance on maintenance field forces, and the benefits of the present workmen's compensation act were adapted. —*Julian Montgomery, State Highway Engineer, Austin.*

Nevada right-of-way

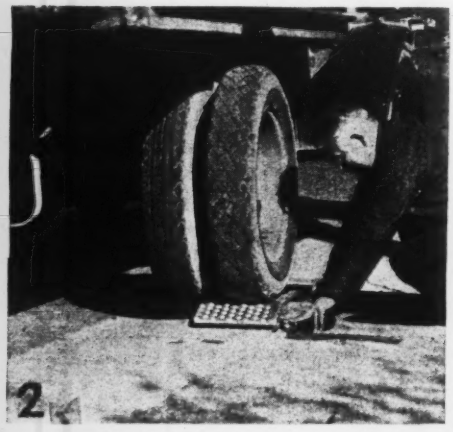
Nevada is endeavoring to secure a minimum width of right of way of 150 ft. over privately-owned land, 200 ft. over state and county-owned land, and 400 ft. over government- owned land. Our present state road system has quite a few miles of highway with narrow and inadequate right of way width, and the problem of widening is very difficult due to the exorbitant monetary demands made by the public. Our department is endeavoring to enlist the aid of the counties of the state to help shoulder these demands.—*Robert A. Allen, State Highway Engineer, Carson City.*

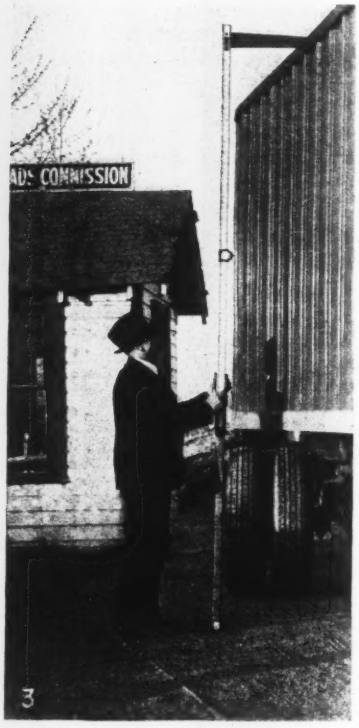
Arizona design for speed

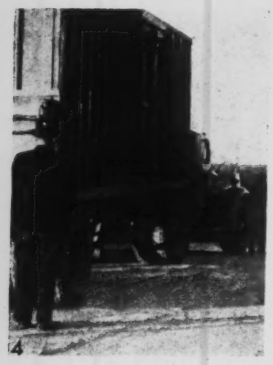
A change in roadway cross-section and in road alignment and profile is in progress. Sight distance and curve design are based on assumed vehicle speeds varying from 45 to 100 mi. an hour. All

Continued on p. 68

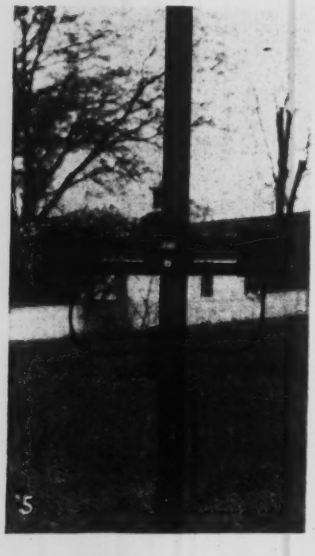
ONE STATE'S PLANNING

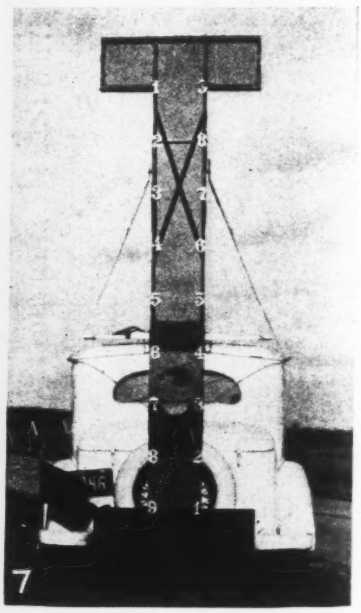






INSTRUMENTS used in Maryland planning survey. 1.—As busses and trucks approach a loadometer station they are halted by warning signs. 2.—The loadometer is placed under the rear wheel and the load reading is taken. 3.—At the same time the height of the vehicle is determined by a gooseneck measuring rod. 4.—The length and width of the vehicle are measured by tape line. 5.—Automatic traffic counts are made by an electric eye as vehicles pass along the road on their regular business. 6.—A theodolite mounted in the front of an automobile takes readings on a stadia car to determine sight distances. 7.—The stadia car travels about 1,000 ft. ahead of the observer's car.





Paving Brick Association has made observations on the internal structure of paving brick manufactured with various degrees of vacuum and methods of forming, with a view to further perfecting plant practices.

The standard specifications for paving brick of the A.S.T.M., of 1929, had not been revised until 1937, when new tentative specifications designated as C 7-37 T were adopted. The most notable innovation is the additional requirement to the rattler test that limits the number of broken pieces weighing 1 lb. or more. An investigation indicates that there is close coordination between broken brick in the rattler and low flexural strength. In addition the rattler test is considered a criterion of toughness. This is the first time that the rattler test, which was devised in the United States, has been modified.

Joint Fillers—For several years a prominent activity of the research bureau of the National Paving Brick Association has been the search for non-exuding brick fillers. Following laboratory tests (*ENR*. Feb. 21, 1935), a brick test road was built in which some score or more of different joint fillers were used. As a result of continuous study of this test four of the fillers were included in the specifications for bituminous-filled brick pavements adopted by the American Association of State Highway Officials. They can be described in general terms as follows: (1) A blended asphalt, being 65 per cent mid-continent base and 35 per cent asphaltic base; penetration at 25 deg. C. of 23 to 32; softening point 101-110 deg. C.; (2) A blended asphalt very similar to the above, with 20 or 30 per cent finely divided mineral content; penetration at 25 deg. C. of 17 to 26; softening point 107-116 deg. C.; (3) A special coal tar pitch; penetration at 25 deg. C. of 35 to 65; softening point 60-75 deg. C., and (4) a plasticized sulphur-asphalt mixture with sulphur content 38 to 42 per cent; penetration at 25 deg. C. of 28-34; softening point 65-75 deg. C.

Bed Course—The bituminous-sand-mastic bed is increasing in favor. Mastic material has the advantages of being water-proof and stable and of having considerable ability to bridge over cracks in the base. The problem is to obtain a mixture that will contain ample bitumen content that can be prepared without expensive plant equipment and that can be readily handled and shaped.

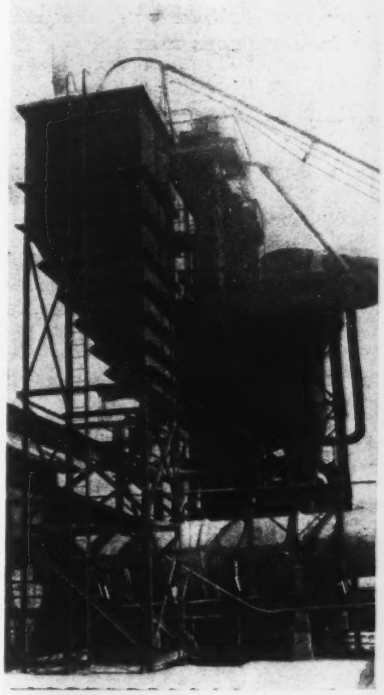
GEO. F. SCHLESINGER
Engineer-Director, National Paving Brick Association, Washington, D.C.

Concrete

Concrete mix design changed but little in 1937. There was some stiffening of control, particularly in the gradation of aggregates, by some states, and New York state has extended its specifications (see p. 57) to include other cements besides straight portland. In research, study has progressed on protective treatments and on soundness tests.

Protective Treatments — During the severe winter of 1934–1935 the unusually heavy and prolonged applications of sodium and calcium chlorides to concrete pavements for ice removal caused scaling of young concrete pavements in some of the northern states. The Portland Cement Association research laboratory undertook to find a practicable method for protecting pavements against such action.

Information obtained previously indicated that the solution would lie in the application of some protective film; consequently, experimental tests were directed along these lines.



Dust bin and part of mixing tower at Detroit's asphalt plant.

Several hundred concrete slabs 1 ft. square were given a surface finish like that of standard pavements. Then, after freezing layers of ice onto the slabs, the ice was thawed by sodium or calcium chloride. Using relatively young concrete, this treatment caused appreciable scaling with only one or two freezings. It was found, however, that the application of drying oils, the best of which was boiled linseed oil cut back with thinners, would completely protect the slabs for an almost indefinite period.

Acting on the results of these experiments several highway departments have treated sections of concrete pavement with linseed oil. Its application has been found to be practical and economical.

Autoclave Test for Soundness—Acting on the conviction that the present standard test for soundness of portland cement was not adequate, the research laboratory of the Portland Cement Association began to study a modification of the autoclave test, which was first introduced by H. J. Force some 20 years ago. It will take a considerable period to effect a complete correlation between results of this test and service behavior, but the results obtained to date indicate that the autoclave test is of sufficient merit to justify its use as a performance test for cement.

Because of these findings the cement manufacturers, at a special meeting held in Chicago on Feb. 18, 1937, voted that no cement would be shipped which showed an autoclave expansion in excess of 1 per cent. At present, about 125 plants are using the autoclave test in connection with the control of the quality of their products. It is anticipated that after a period of use it will be possible for A.S.T.M. Committee C-1 to set up a standard for this test.

WM. M. KINNEY
General Manager, Portland Cement Association, Chicago, Ill.

Crushed stone

Methods of production and use of crushed stone have been developed over a long term of years and for the most part they have remained unchanged during 1937. Certain developments, however, are worthy of mention.

Prepared stone sand for use as a fine aggregate is now a recognized crushed stone product. More definite

ideas as to its proper gradation have been developed and during 1937 specifications have taken a trend toward the use of finer sizes. Thus, specifications have required a maximum size of particle which will pass the No. 4 or even the No. 8 sieve, whereas hitherto the 3/8-in. sieve was permissible; also, more material passing the No. 50 and the No. 100 sieves has been required to produce workability and reduce water gain. This tendency is in line with specifications for natural sand. Attention has likewise been paid to the production of more favorable particle shape of stone sand by the use of special crushing and grinding equipment. The hammer mill, ring mill, rod mill and crushing rolls have given good results.

Testing engineers have given considerable thought to the shape of the coarse fragments of crushed stone. Although flat and elongated fragments are not considered desirable, evidently technical information is not available for specification purposes. The standardization of sizes is a recent very important advance, not only in the crushed stone industry, but also in other aggregate industries. Division of Simplified Practice Recommendation R163–36, issued in June, 1936, gives a recommended standard for sizes of coarse aggregate. Many of the states have adopted this standard.

In research matters, many things are in the offing. The study of bituminous mixtures is being continuously developed and replenished with new ideas. Investigations of the adhesion of bituminous materials to stone and researches with the Los Angeles rattler, particularly to correlate its results with service behavior, have been very active.

Investigations in the laboratory and in the field have indicated that quarry fines which are waste products in many quarries have considerable value for use in low-cost bases. They have been used alone or with admixtures of various kinds including salts, or bituminous materials.

A. T. GOLDBECK
Engineering Director, National Crushed Stone Association, Washington, D.C.

Sand and gravel

These materials have in recent years gone through all the developments that a constantly more exacting roadbuilding practice has called for. Some of the many developments that continued active through 1937 and are still in progress are the following:

The National Sand and Gravel Association has paid considerable attention to the development of specifications for sand and gravel in bituminous mixtures and has issued recommendations with particular reference to roadmixed types. Increased use in bituminous mixtures has directed interest to research problems to which previously little attention was paid. Prominent among these is the effect of mineral composition and surface texture of aggregates on adhesion of bitumens, and the effect of shape of aggregate particle on stability and durability of bituminous mixtures. These are being studied in a preliminary manner and further studies are planned.

The recent attention to stabilized road construction has also introduced new problems. Some progress is being made in the production of plantmixed stabilized mixtures, but the area in which they can be marketed has a short radius.

In the concrete highway field the principal developments affecting sand and gravel come from the greater rigidity of specifications. Not only do the specifications for grading provide smaller tolerances than heretofore, but the requirement for more than one size of coarse aggregate appears to be becoming universal. Simplified Practice Recommendation R163–36 is being accepted in a gratifying number of cases and has been or is being incorporated in the specifications of the American Association of State Highway Officials, the American Society for Testing Materials, the Joint Committee on Concrete and Reinforced Concrete, and a number of different state highway departments. On the other hand, as there are still some

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REPORTS OF STATES
—*Continued*

curves are spiraled and superelevated; sight distance is proportioned to the stopping distance for the designed speed. In cross dimensions, traffic lanes are 11 ft. wide and shoulder widths vary from 2 ft. on secondary roads to 8 ft. on primary roads. Cut and fill slopes are flattened; cut slopes are 1 on 4 and are rounded to reduce erosion and they transition into fill slopes of 1 on 1½. The trend is toward less guard rail and to the use of white guide posts spaced 40 to 100 ft. apart on the shoulders.

In small bridge structures the tendency is toward continuous-girder and rigid frame types.

In highway research, particular attention is being given to soil studies and to the hardening of asphalt in asphaltic concrete. (*ENR* May 27, 1937). *T. S. O'Connell, State Highway Engineer, Phoenix.* (This statement was received before the regrettable death of Mr. O'Connell.)

California design policy

The California division of highways has made within the past four months important changes in design policy.

Wider Roads Hereafter—Increase in the speed of the average car and in the width and number of fast-moving trucks and busses has made it apparent that 10 ft. traffic lanes are insufficient for safe passing. It is now proposed than an 11-ft. lane shall be used on all new construction, making two-lane pavements 22 ft. wide and three-lane pavements 33 ft. wide. In the construction of four-lane pavements the new standards provide that opposing traffic will be divided by a parting strip between the two inside lanes and that the inside lanes shall be 12 ft. wide and the outside lanes 11 ft. wide. Similarly, the width between curbs on bridges and structures will be increased; where now a bridge on a road with 20-ft. surfacing is 24 ft. between curbs, under the new policy, with 22-ft. pavement, the bridge deck will be 26 ft. between curbs.

Construction practice for divided traffic ways on four-lane highways provides for curbed parting strips of variable widths with 4-ft. determined as the minimum width. Experiments with both paved and planted dividing strips have been made. Where conditions permit construction of parting strips 20 ft. or more in width, the policy is to omit the curb.

Renovating Old Bridges—The most pressing problem in bridge construction is the replacement of the many narrow and obsolete structures. A survey of the 14,000 mi. of state highway revealed that of the 3,280 bridges on the system, 250 were in such condition as to demand immediate replacement to accommodate safely the traffic loads which they are called upon to carry, and about 1,000 more were not built in accordance with modern structural standards and should be replaced within the next ten years.

It is estimated that the immediate replacement of the 250 poorest bridges will require about $7,000,000 and those which should be replaced within the next ten

states that do not consider these sizes suitable, they are again being studied with a view to recommending revisions that will make them more generally acceptable.

Specifications for grading of fine aggregate show more rigid requirements for uniformity, and it is becoming more common to supplement the usual grading limitations with a uniformity clause—generally based on fineness modulus. There are indications that such clauses may work undue hardships on producers, not justified by economy, and the association is now conducting further studies of what uniformity may be expected from the modern established plant under average conditions.

Many producers point to the increased use of their material in highway construction through the medium of ready-mixed concrete. This statement is particularly applicable to construction of the nature of grade separations, bridges and the like, although ready-mixed concrete is being used in a considerable amount of slab work.

STANTON WALKER
Director of Engineering, National Sand and Gravel Association, Washington, D. C.

Developments in tar

The principal development in tar for roadbuilding is in new and improved uses as discussed in another section. However, progress has been made in standardizing tar nomenclature and grades.

The old designations of low-carbon tar for water-gas tar and high-carbon tar for coal tar are now obsolete, since the heavy water-gas tar as manufactured at present has a comparatively high content of free carbon. During the past two years specifications have been prepared under which both water-gas tars and coal tars can be furnished. These specifications are under consideration by the American Society for Testing Materials and the American Association of State Highway Officials. In all probability a single series of specifications will be adopted by each society. As a part of this investigation, the entire range of tar grades has been reviewed.

GEO. E. MARTIN
Consulting Engineer, The Barrett Co., New York

Investigations in slag

During 1937 in continuing rather lengthy investigations the National Slag Association laboratory has developed considerable data in the field of bituminous and cement concrete research. Probably the one outstanding research project during the year was the study of the Los Angeles abrasion test as it is related to slag.

With regard to the mechanical processing of blast furnace slag, the installation by several companies of flat vibrating screens in place of the older type revolving screens or inclined vibrating screens has been an outstanding change. Individual companies have done a considerable amount of experimental work in the production of a specially-processed lightweight slag aggregate.

For several years the industry has been greatly interested in the adaptability of blast furnace slag to the comparatively new art of scientific soil stabilization, and a great deal of study has been given to the theory and to economic problems. In practice, plants serving metropolitan areas with slag-soil stabilized mixtures have provided many miles of road surfaces of unusually high quality. They are now being studied in their second year of service to establish facts regarding behavior.

Research and tests preliminary to a comprehensive laboratory investigation of bituminous mixtures are under way and it is anticipated that this will be completed during 1938.

H. J. LOVE
Manager, National Slag Association, Washington, D. C.

Soil stabilizing agents

Besides asphalts, cements and tars, the common soil stabilizing agents are calcium chloride, lignin and sodium chloride. No special changes in these agents as materials have taken place, but their uses have been extended, as described elsewhere.

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years will require an additional $25,000,000.—*C. H. Purcell, State Highway Engineer, Sacramento.*

11-ft. lanes in Oregon

An important advance in our standards of construction was the adoption of the 11-ft. width for traffic lanes on main highways. The standards of alignment, grade, vertical curvature, etc., used in the construction and reconstruction of main highways were those required for safety at a speed of 60 mi. per hour. All curves were spiraled.

Investigations to determine means of overcoming unsoundness in concrete, although not yet completed, have led to changes in specifications for fine aggregate for concrete, and to adopting for general use in the colder portions of the state, the class of cement which has been designated by the Procurement Division of the federal government as "moderate-heat-of-hardening portland cement."—*R. H. Baldock, State Highway Engineer, Salem.*

Washington's new code

Materially assisting the highway department in its accomplishments for 1937 is the New Highway Code, which simplifies procedure and eliminates the obsolete, conflicting and antiquated provisions which have accumulated over years of periodic highway legislation. The subject matter of the code falls into four broad classifications, each of which was passed as a separate act by the 1937 legislature: (1) the administration of state highways, including both primary highways and secondary highways, is contained in Chapter 53; (2) the administration of, and state aid to, county roads and city streets is contained in Chapter 187; (3) motor vehicle ownership, registration and licensing, and the registration, licensing and regulation of motor vehicle operators is contained in Chapter 188; and, (4) provisions relating to motor vehicle equipment and rules and regulations for the operation of motor vehicles on the public highways is contained in Chapter 189.—*L. V. Murrow, Director of State Highways, Olympia.* (A full account of this new development will be published in a future issue.—EDITOR)

Idaho crossing elimination

With the coming of the program to eliminate railroad grade crossings it was found that a majority of the overhead structures were to be constructed at locations where the terrain is comparatively flat, requiring high approach embankments. Since the standard railroad clearances are the designing factor, the continuous beam type is adopted. This gives less depth of stringers over the tracks with a resulting decrease in the height of approach embankments. The curved lines that it is possible to introduce with this type of structure are pleasing in appearance and harmonize with the vertical curve of the approach embankments.

Legislation was passed in 1937 providing that a person to whom a contract is awarded must enter into contract and furnish bond within 15 days after pre-

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Research Aids Increased

by E. F. KELLEY
Chief Division of Tests, Bureau of Public Roads, Washington, D. C.

Laboratory and field experimentation has been increasingly active and a number of definite accomplishments during the past year are reported

THE CULMINATION OF RESEARCH, in the sense of reaching a final objective, is seldom if ever attained except after a relatively long period of study and experimentation. This is as true in the field of highway materials as in any other and therefore the accomplishments of a given year must be evaluated more on the basis of current developments than on the basis of completed work. The following is a brief summary of the more important developments or, perhaps more properly, the trends in development in road material research in 1937.

Portland cement

A type of concrete failure that has become increasingly prevalent in recent years is due to an abnormal expansion of the concrete that does not manifest itself until after several years of service. In pavements this expansion results in multiple cracking which may be followed by raveling and ultimate disintegration. There is considerable evidence to indicate that this behavior is due to unsoundness of the cement that is not revealed by the present A.S.T.M. soundness test. A great deal of attention has been given to possible means for correcting this situation and the latest development is the revival of the Force autoclave test that was used by the Lackawanna R.R. about 20 years ago. The new test procedure is the same in principle as the Force test but differs in certain details. It is much more severe than the usual steam test for soundness and it is hoped that it may serve to detect those cements that develop unsoundness only after considerable periods of time. (See p. 67.)

Aside from investigations initiated by the manufacturers, the only work that has been done so far has been in connection with refinements in the test procedure. It is now in order to attempt a correlation of test results with field experience; significant test limits have to be established for use in specifications if the consumer is to be given any real protection against this type of unsoundness in modern cements.

Coarse aggregates

The enthusiasm with which materials engineers have greeted the proposal to adopt a new test for quality of coarse aggregates indicates the general dissatisfaction that exists with respect to the Deval abrasion test and the toughness test that have been in use for many years. The Los Angeles abrasion test, designed to replace these two tests, has been adopted as a standard by the American Association of State Highway Officials and as a tentative

REPORTS OF STATES —*Continued*

sentation. Another act provides for a license tax of ½ per cent of the amount of contract for the privilege of contracting for the construction of state highways. A bill was enacted which requires that contractors on public works must pay all delinquent taxes, except taxes on real estate, before being awarded contracts and directing contracting units to withhold payment until such requirements are satisfied.—*J. H. Stemmer, Director of State Highways, Boise.*

Montana

We have definitely raised our standards for right of way; the minimum width for right of way is now 100 ft., except in unusual cases where costs are exorbitant or in cities or towns where improvements and developments already made will not reasonably permit this width. The wider right of way provides space for wider and shallower borrow pits, increasing visibility on horizontal curves, and generally promotes the safety feature we are trying to build into our highways.

We are also constantly increasing our standards of road design. Some of the present completed highways have only a 22- or 24-ft. wide grade with an oil surface mat from 18 to 20 ft. wide. This makes the traffic lane only 9 or 10 ft. wide, which is not sufficient for present day traffic, particularly the narrower width of 9 ft. We consider the three-lane highway more of a menace and danger to traffic than the two-lane highway of adequate width. Accordingly, in the new design of main roads we are providing for a grade of 30 ft. width with a 24-ft. oil mat and a 3-ft. shoulder on each side. This gives a traffic lane of 12 ft., eliminates the tendency for traffic to crowd the center line and minimizes the danger of head-on collisions. We are designing in other ways for additional safety, such as providing increased sight distance on both horizonal and vertical curves; reducing curvature and straightening alignment when possible, even at some expense in having heavier grades for short distances; requiring flatter side slopes with broad and shallow borrow pits; providing turnouts for scenic views, or for safety spots for parking off the highway; and specifying an increased depth of subbase material for stabilization and to combat capillarity, which is so destructive to oil mats.—*D. A. McKinnon, State Highway Engineer, Helena.*

Wyoming's peculiar problem

Wyoming has a problem which is far different from a majority of the states in the Union. Traffic volumes are such that construction is not required to be of the first class. However, with the towns a considerable distance apart and with level terrain, traffic appears to move with greater rapidity here than in other areas. With this in mind, then, it has been necessary to keep designing and construction standards well advanced.

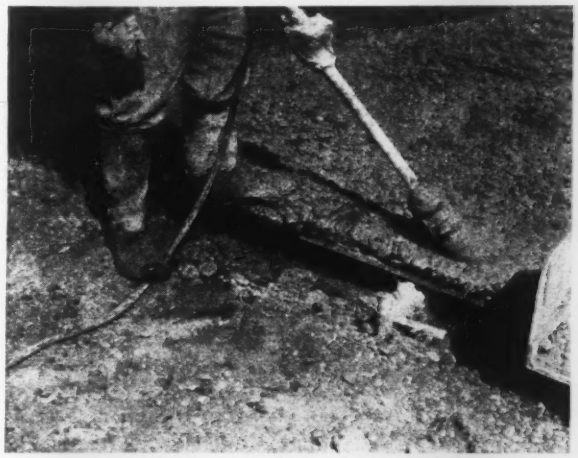
On the five principal routes of the state,

standard by the American Society for Testing Materials. Research during 1937 has included the assembly and analysis of test data and the correlation of test results with service behavior, both in portland cement concrete and in bituminous construction. A report on this work, with recommendations concerning appropriate test limits for use in specifications, was presented at the 1937 meeting of the Highway Research Board (*ENR* Dec. 16. 1937). The Los Angeles test has been adopted by several state highway departments as a basis for the acceptance of coarse aggregates for various types of construction and the committee on materials of the American Association of State Highway Officials has adopted test limits which will be utilized in revisions of the association specifications.

Bituminous materials

For specification purposes new tests have been devised and old ones resurrected, among which are several that are based on susceptibility to change in consistency as affected by change in temperature. Investigations are being made in a number of laboratories of types of viscosimeters suitable for the purpose. As yet no attempt has been made to specify viscosity requirements in terms of absolute units.

The increased use of liquid asphaltic products and bituminous mixtures of the open-graded type, together with an undue lengthening of the construction season, have resulted in many failures of road surfaces due to the inability of the aggregates to remain coated with asphalt in the presence of water.



Investigations show that vibration strengthens concrete.

These failures have emphasized the importance of resistance to so-called film stripping and a number of tests proposed for the measurement of this resistance are being investigated.

One of the most important characteristics of an asphaltic road material is its durability when exposed to the action of the elements, and probably more attention is being given to studies of the weathering characteristics of asphaltic materials than to any other phase of an extremely complicated problem. Various accelerated tests are being made, including the exposure of the materials, both in thin films and in bituminous mixtures, to atmospheric conditions in the open and to heat and light under controlled conditions in the laboratory. A variety of tests made before and after exposure are used to evaluate relative resistance to weathering. One of the notable contributions of the year on resistance to weathering was the test developed by J. R. Benson of the Kansas highway commission and reported at the 1937 meeting of the Highway Research Board (*ENR* Dec. 16. 1937). In this test, which appears worthy of further study, a thin film of material on a glass slide is heated in an oven and the changes that take place are observed under a microscope.

Another important group of investigations is concerned with the changes that take place in asphalt during the mixing and placing of hot-mix pavements and subsequently during their service life. It is known,

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all new construction is being based on an 80-mi. per hr. speed standard. Roadway widths of 36 ft. are used with a 24-ft. oiled way laid between graveled shoulders. The department adheres to a standard 11-ft. minimum width of traffic lane. With the center-line strips and allowing ample shoulder width, the construction of the 36-ft. roadway proves to be almost ideal for two-lane roads. On the other routes of the state a lower speed standard is used and 30-ft. roadway having a 22-ft. oiled mat is constructed with 4 ft. for shoulders on each side. These routes carry traffic that is predominantly local. In the first classification the sight distance is 1000 ft. and in the second it is 600 ft.—*C. F. Seifried, Superintendent-Engineer, State Highway Department, Cheyenne.*

North Dakota reorganization

Construction in North Dakota was almost at a standstill during 1937 because of financial difficulties and a reorganization which was accomplished on Sept. 1. It is now expected that plans for necessary finances for maintenance of the state highway system and for matching federal-aid funds will be developed and made effective so that North Dakota highways will be in the same class as those of other states. The funds available for construction would permit a program approximating $8,000,000 in 1938 and the first contracts for such program are advertised for bids.—*Z. E. Setison, State Highway Engineer, Bismarck.*

Kansas trunk highways

Highways carrying in excess of 4,000 vehicles a day are being designed with separated pavements of two lanes each. Where funds are not available at the time of construction for building four lanes sufficient right of way is procured to construct a four-lane pavement, but only two lanes are first constructed. Where speed is the controlling factor, a minimum sight distance of 1,000 ft. for both horizontal and vertical curves is provided. All horizontal curves having a radius of less than 3,820 ft. are provided with spiral transitions. Shallow ditches and flat slopes are also to be provided on all new work that is undertaken.

Two major bridges placed under construction in 1937 are the Missouri River bridge at Atchison, Kan., a joint project with Missouri to cost about $610,000, and the Topeka Ave. bridge at Topeka, Kan., to cost $1,592,000. The river bridge alone of the Topeka project involves spans of 155, 186, 217, 186 and 155 ft., and is of continuous plate-girder construction. The center span of 217 ft. is believed to be the longest span in this country involving this type of construction. The depth of girder over piers is 16 ft. 1 in. Both the Atchison and Topeka bridge projects involve the closed caisson method of foundation construction.

In addition to its regular testing the department has carried on research on vibration of concrete, concrete mixes, soils, translucent asphaltic film and the collecting of data on the Lawrence experimental

Continued on p. 72

of course, that all asphalts are altered to some extent by the heat and oxidation to which they are subjected in the mixing process and it is also known that asphalts extracted from pavements after a period of service are harder than before use. Efforts are being made to determine the degree of alteration that may be permitted to take place in mixing and placing; the relation of that which takes place during construction to that which develops subsequently, and the effect of these changes on the performance of the pavement. Work of this character has been aided greatly by the development of the methods of Abson and Bussow for the recovery of asphalt from paving mixtures.

Soil mechanics

Ten years ago highway engineers, as a class, knew nothing about soils and the majority appeared to care less. Now we have a great deal of information of definite practical value and most of the state highway departments are utilizing this knowledge and endeavoring to increase it.

It has long been known that properly-designed sand-clay-gravel mixtures of the mechanically stabilized type that can be used with success as surfacing materials, are very likely to fail if used in base courses for bituminous surfaces. Research and past experience bore fruit in 1937 with the result that the character and amount of the soil binder may now be defined with sufficient precision so that this type of failure should be less prevalent in the future. These findings have been utilized in a specification for mechanically stabilized bases that is being considered for adoption as a standard of the American Association of State Highway Officials.

In contrast to mechanically stabilized bases, in which stability is dependent on mechanical grading and the amount and character of the soil binder, are stabilized bases in which asphaltic materials, tars and portland cement are used as admixtures. In these types of stabilization the mechanical grading is not of primary importance. The admixtures are used to overcome the detrimental effects of defective grading and of soil binder in excessive amounts or of poor quality. The interest in this form of construction has been on the increase for several years and 1937 saw a great deal of research on fundamentals and the construction of a number of experimental roads in several states.

Definite advance has been made in establishing the principles underlying the selection of suitable fill materials and their utilization in embankment construction and highway engineers are beginning to put these principles to practical use. In this work the Proctor compaction test has proven a most useful tool both in research and in the control of embankment consolidation. The test is utilized in a proposed specification for fill materials of the American Association of State Highway Officials.

Studies of the warping of concrete pavements, prevalent on certain types of soil in various parts of the country, have continued. A number of investigations have been or are being made and a committee of the Highway Research Board has been active during the year in assembling and correlating the data from these projects.

Soil mechanics, as related to foundations and the stability of large earth structures, is being utilized to an increasing extent with the ever increasing knowledge of the subject. A valuable contribution was made by Palmer and Barber in a report published in *Public Roads* (March, 1937) which clarified the theory of soil consolidation and the methods of using the data from the compression test in computing settlements of foundations. Progress has been made in the application to practical problems of the data from shear tests of soil and in the use of the stabilometer for determining earth pressures as they affect the stability of retaining walls, cofferdams, etc.

The studies of the surface chemistry of soils, for the inception of which we are indebted to Winter-

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REPORTS OF STATES
—*Continued*

paving project. (*ENR* March 18, 1937). —*A. B. Nuss, Kansas State Highway Engineer, Topeka.*

South Dakota surfacing

Adequate funds for financing maintenance and federal aid matching have been assured by the return of the full 4c. of the gasoline tax to the highway department by the 1937 state legislature. Therefore plans are being formulated for a balanced program to insure within a year a dustless highway east and west across the state. Connecting links on many of the main highways are to be reconstructed, and within a period of two years should interconnect all cities of 10,000 with bituminous and concrete roads.

On new construction and reconstruction, rights-of-way of 100 ft. and wider are being used, roadway surface widths are being increased and inslopes and backslopes have been flattened to increase safety and assist in maintenance. Grades in general have been raised to eliminate the snow hazards of winter and per cents have been reduced, giving greater sight distances. Heavier base courses are being used on bituminous sections with lighter mats. Bases are being compacted more thoroughly by the use of both water and oil, special treatments being given where subsoil conditions make this necessary.

Bridges and other structures are being designed with wider roadways. Special attention is being given to the construction of bridge floors to insure better riding qualities.—*J. H. Lake, State Highway Engineer, Pierre.*

Nebraska research use

Nebraska has been among the first of the states to make practial use of research in the field of soil compaction and soil stabilization. Building on earth grade used to consist simply of hauling dirt from a cut and placing it in a fill to the desired height. No attention was paid to the type of soil that came out of the cut. Later the rolling of fills was developed. Today the soils are classified and often selected material is used. It is not only rolled but through laboratory tests the relation between moisture content and compacted soil density is determined for the soils on each project. Having determined in the laboratory the amount of moisture required for maximum compaction in the various soils to be encountered on a project, field tests are conducted during construction to determine the amount of moisture present, and if this is insufficient for maximum compaction the deficiency is supplied by hauling water and sprinkling.

Progress has been made in soil stabilization which is now being used to provide an adequate base for bituminous mat paving. The development of this relatively cheap method of base stabilization has made possible much greater use of bituminous mats and has greatly increased the mileage on which this type of pavement will be adequate. Similar improve-

korn, have indicated the importance of chemical and electro-chemical reactions as they affect the engineering properties of soils and the possibilities of chemical treatment of one kind or another for changing those properties. These studies are being continued and extended.

Concrete vibration

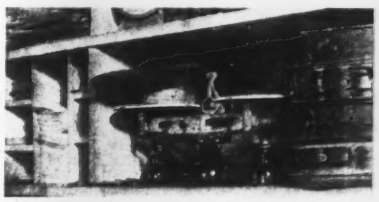
The numerous investigations that have been made have established beyond reasonable doubt the merits of vibration as applied to pavement construction. In view of this it is somewhat surprising that there has been so little practical use of the method except in projects essentially of an experimental nature. With a properly designed mixture tests prove that vibration produces pavement concrete of greater density than standard methods of placing and it may be utilized to increase the strength of the concrete without reduction in cement factor, or with a lower cement factor to obtain the same strength.

Pavement design

The structural performance of pavements of both the rigid and flexible types has continued to engage the attention of research engineers. Both experience and research have shown the need in non-reinforced concrete pavements of short slabs and a correspondingly close spacing of joints for the control of stresses and resultant cracking. Present practice in pavement construction recognizes this need and the large number of transverse joints, both expansion and contraction, that are now used has emphasized the importance of their proper design and installation.

Many new types of joints have been developed and a great deal of testing has been done in an effort to determine their adequacy. However, the progress made has been somewhat slow, since the determination of the efficiency of joints in supporting loads does not lend itself to simple laboratory tests but requires laborious observations on full-size pavement sections. However, aside from efficiency in load support, observations of the behavior in service of some of the newer types of joints is beginning to crystallize opinion regarding them.

Westergaard's mathematical analysis of the stresses in concrete pavement slabs has given a rational basis for the design of this type of pavement. An extensive study by the Bureau of Public Roads in which stresses computed by the Westergaard formulas are compared with observed stresses in full-size slabs is nearing completion. Publication of a report on this work is scheduled for 1938. Similar efforts are being made to develop a rational method for the design of pavements of the flexible type, but little progress can be reported. The paper presented by A. C. Benkelman at the recent meeting of the Highway Research Board was an excellent exposition of the complicated nature of this problem and how little is known about it.



Convenient storage space is an asset to a highway research laboratory.

Research better supported

An item that seems worthy of mention is the increased support, as compared with that of a few years ago, that is now being given to highway research work. There is a greater general appreciation of the need for this work, with the result that more organizations than formerly are interesting themselves in it and more technicians are employed. A general statement applicable to all this work, and particularly to that in soils, is that the knowledge of the research workers is considerably in advance of the published record. In the discussion herein of improved materials other research activities are more properly considered in connection with the progress of the particular roadbuilding material.

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ments have been made in the construction of the bituminous mats themselves in the way of materials, equipment and methods of processing.—*A. T. Lobdell, Chief, Bureau of Roads and Bridges, Nebraska, Lincoln.*

Missouri Safety Bureau

The state highway department inaugurated in 1937 a new division known as the Safety Bureau, which will have charge of traffic control and safety.—*C. W. Brown, Chief Engineer, State Highway Department, Jefferson City.*

Iowa stabilization

A variety of stabilizing agencies, including clays, portland cement, calcium chloride and several different bitumens have been used on stabilized base projects. It is believed that stabilized bases have a very definite place in this state's rebuilding program.

On projects which involve the grading or regrading of a highway, the design is completely developed from right-of-way line, with the thought that roadside improvement to be undertaken at some future date will then require only the planting. In roadside design, consideration is also given to snow storage and snow removal.

A thin bituminous wearing surface of the inverted penetration type, on a stabilized base, is believed to be the economical design for roads not subjected to heavy concentrated traffic. Further experience with this type of construction is needed to develop design and construction technique. — *C. Coykendall, Administration Engineer, Iowa State Highway Commission, Ames.*

Safety in Illinois

Probably the most important step in traffic control and safety in Illinois was the establishment of the State Highway Safety Commission. This commission was appointed by the governor to analyze the highway accident situation in the state and to make recommendations concerning legislation, enforcement, judicial procedure, highway modernization, public safety education and other phases which might contribute to a reduction of traffic accidents in the state. The commission is developing a plan of coordination of the safety activities of all Illinois groups to avoid duplication and conflicts and to produce greater harmony of purpose and effect.

The state is using more foresight in the initial acquisition of rights of way for highways. Where widening or other developments can be reasonably anticipated in the future, sufficient widths to accommodate such future developments are secured in the original acquisition. The minimum widths of right of way are now greater than they were a few years ago, due to the practice of using wider shoulders, flatter slopes, and of landscaping.

Probably the most important feature of recent design activities has been the adoption of vehicular speeds as one of the

Continued on p. 74

Design Perfects Line and Profile

by R. E. Toms
Chief, Division of Design, Bureau of Public Roads, Washington, D. C.

The major trends of road design are dictated by safety and concern alignment, grades, curves, cross-profile and intersections

THE MOST SIGNIFICANT TRENDS in highway designs during the year 1937 have been along lines of geometric rather than structural advance. This is logical since during the period of highway development following the advent of the automobile engineers have concentrated upon problems of road surfaces. The result is that the structural features of highway design, in a large measure, have been solved.

Smooth, structurally sound roadway surfaces combined with advances made in automobiles have resulted in a rather sudden and marked increase in the speed of highway travel. There has also been a decided increase in large busses and trucks and trailers operating at high speed. Sudden sharp curvature, the clearance between vehicles and the ability to pass overtaken vehicles become critical problems when traffic moves at high speed, and failure to deal with these problems adequately creates traffic hazards. Safety therefore is the basis of the major trends of highway design for 1937, and these concern the geometric phase of design—that is, with alignment, grades, curves, widths, intersections, etc.

Speed

Highway designs in the future will be based upon an assumed design speed at which traffic can move with reasonable safety. This practice is rapidly finding adoption, as reports from state highway departments (p. 54) bear evidence. The assumed design speed will range from 60 to 70 mi. per hour for highways in average topography, and corresponding by less in more rugged topography. Critical speeds may be greater than the assumed design speed. Where economic considerations dictate the inclusion of substandard sections in the design they will be marked by signs that are visible both day and night to indicate the safe speed of travel. Several states are now undertaking in a limited way to sign relatively sharp curves for safe travel speed.

There is a growing recognition that highway safety is increased by a greater width of traffic lane. The legal over-all width of busses and trucks in most states is 8 ft. Experience and observation both indicate that a 10-ft. traffic lane is no longer adequate for modern high speed traffic. A basic 11-ft. traffic lane has already been adopted by some states, and the general trend undoubtedly is toward greater traffic lane width.

When traffic volume justifies as many as four traffic lanes there is a decided trend toward the separation of traffic in opposing directions by a median strip or a parkway of varying width. On wholly new construc

REPORTS OF STATES —*Continued*

controlling features in designing the highways. In the application of this theory Illinois is attempting to allot a reasonable factor of safety to insure our roads against obsolescence resulting from greater development in automotive speeds.—*Ernst Lieberman, Chief Highway Engineer, Illinois Division of Highways, Springfield.*

Surfacing in Wisconsin

The high light of Wisconsin's program in 1937 was the surfacing and dust-proofing of the state trunk highway system. This work was completed in the late summer. The status of the surfacing on the primary 10,000 mi. system at the close of the current year can be briefly summarized as follows:

Portland cement or bituminous concrete surfacing	4,685 mi.
Intermediate type bituminous surfacing	1,900 mi.
Light bituminous treated surfacing	3,415 mi.

The maintenance program for 1937 was the largest ever undertaken by this state. The 1937 program included the placing of 3,000 mi. of light-oil aggregate surfacing on the state trunk highway system and placing of 225 mi. of heavy type bituminous bound gravel surfacing and 550 mi. of seal coats on previously built bituminous surfaces. Upon the completion of this program the entire state trunk highway system of 10,000 mi. was dustless and smoothly surfaced.

During the year distinct progress was made in the reconstruction and replacement of isolated bridges which are unsafe because of inadequate load carrying capacity, narrow roadways or hazardous approaches. This work was undertaken in addition to the routine bridge construction involved and necessary under regular road projects. A major bridge project placed under way is the construction of a new bridge over the Mississippi River at La Crosse, Wis. The total length of bridge and approaches is one mile. The bridge proper is 2,600 ft. long, consisting of a combination of deck trusses, plate girders, and I-beam spans with a cantilever unit over the main channel having a clear span of 475 ft. Contracts have been let and work is under way for the substructure and approach embankments. The entire project estimated to cost $1,500,000 is planned for completion early in 1939. —*E. L. Roettiger, State Highway Engineer, Madison.*

Indiana divided lanes

In an attempt further to build safety into highways, two major projects of divided or dual-lane pavement have recently been completed and opened to traffic. These two new divided lane thoroughfares have not yet seen sufficient service to offer any conclusions on the improvement of safety for which they were designed. Other divided-lane thoroughfares are planned for future construction on some of the most heavily traveled highways of the state on which reconstruction

tion this is comparatively easy to accomplish in design, but where existing traffic lanes are utilized in expanding the service to four traffic lanes the problem is not so simple. It is being studied with the object of progressing by stage development with a minimum loss of investment.

There is a growing consciousness that highway safety depends primarily upon the ability to see. As applied to highway design this means essentially that sufficient clear vision shall be afforded so that the overtaken vehicles can be passed without hazard, or that the vehicle can be brought to a stop to avoid encountering any obstacles in its path. Passing on two- and three-lane highways, which now and perhaps always will constitute a very large percentage of our highway systems, must be accomplished on a traffic lane that may be occupied by opposing traffic. A safe passing distance under such conditions is much more than double that required to bring a vehicle to a stop to avoid encountering obstacles in its path.

When proper allowances are made for perception time, brake-reaction time and braking distance necessary to bring a fast moving vehicle to a stop it will be found that a sight distance in feet of about ten times the speed of travel in miles per hour is essential. This may be termed a nonpassing minimum sight distance.

While the ideal design for two- and three-lane highways should provide sufficient vision for safe passing at all points, physical limitations of topography sometimes necessitate both vertical and horizontal curvature that make this impossible. It is becoming evident, therefore, that present day highway design must be predicated upon two sight distances, a nonpassing minimum and a passing minimum. There is little economic justification for expenditure of funds for an increase in sight distance greater than a nonpassing minimum unless a passing minimum view is secured. We may therefore expect a conscious effort in future highway design to provide occasional sections with sufficient clear vision for safe passing at intervals certainly not greater than 2 mi. apart for two-lane highways and less for 3-lane highways. Such designs will serve to allay the irritation that builds up in the minds of drivers, pocketed for long periods behind slow moving vehicles with inadequate vision, to the point where even careful drivers throw discretion to the wind.

Appearance

There is increasing evidence that highway designs are being studied more and more from the standpoint of appearance. Flattened and rounded slopes are coming to be the rule rather than the exception. They are more pleasing and have proved their value in decreased maintenance and in preventing soil erosion. Flowing alignment with long easy directional curvature is taking the place of sharper curves interspersed with short sections of tangent. Transition curves are being adopted by more and more states. There is a decided trend toward the utilization of wooded roadside areas for the creation of roadside parks. Abandoned roadways adjacent to new construction are being obliterated and more thought is being given to minimizing the scars of construction. Long shallow fills, usually made from side borrow in the past and leaving in their wake unsightly and unsanitary deep side ditches, are beginning to be made by end haul with flattened slopes that give added safety and appearance and minimize the drifting effect of snow. More attention is being given to the architectural elevations of bridges so as to produce outlines that blend rather than clash with their surroundings.

In the field of structural design the most significant trend has been toward a greater utilization of the principles of soil mechanics in all phases of highway design from fill compaction to soil stabilization. More and closer attention is being paid to building up stable subgrades for both low cost roads and high type pavements through the use of selected materials. Where selected materials are not economically available admixtures are being used to an increasing extent to alter unfavorable soil characteristics

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is necessary.—*M. R. Keefe, Chief Engineer, Highway Commission, Indianapolis.*

Ohio accounting

Ohio inaugurated a new system of uniform maintenance accounting Jan. 1, 1936. To a very large extent the cost accounting classifications are comparable with those in the system which was recently submitted for letter ballot by the American Association of State Highway Officials. The functioning of the Ohio system during 1936 and 1937 has demonstrated the completeness of its coverage, its adaptability and its capacity for expansion to care for future needs. The major benefits gained by the installation of this system are as follows: Uniform practices make for comparability between the various highway divisions; more information available; greater speed and accuracy in the preparation of reports; more prompt approval and transmittal of invoices; perpetual inventory record of materials and supplies; garage operations reflected in terms of profit and loss; increased control of expenditures and physical operations, and complete authenticity of division records by reason of the fact that these records are subject to reconciliation with central office records which are, in turn, periodically reconciled with the records of the auditor of state, thus unifying the entire accounting system.—*G. M. Anderson, Assistant Director and Chief Engineer, Department of Highways, Columbus.*

Michigan finance

Legislative correction of fiscal troubles and improvements in the bases of highway administration have cleared the way for increased construction activity and improved traffic conditions and service. By statute in 1937 the highway department's revenue was placed upon a $32,000,000 a year basis; a direct appropriation from the general fund of the state sufficient to make up the difference between total gasoline tax collections and the $32,000,000 base amount is authorized.

Important among specific works initiated in 1937 is the Port-Huron-Sarnia bridge across the St. Clair River on the Montreal-Chicago highway (*ENR* April 15, 1937). Work this year consisted in constructing the concrete approach foundations on the American side. Similar foundation work was in progress on the Canadian shore. It is expected that the bridge will be opened to traffic in September, 1938.—*Murray D. Van Wagoner, State Highway Commissioner, Lansing.*

New Jersey

The state system has not yet been completed and its full benefits are therefore still to be realized. Additional highways of modern type are yet to be built in various parts of the state; relief routes are needed for accommodation of traffic on several of the more important arteries, and reconstruction of some of the existing routes is imperative to increase safety and facility of operation.—*James Logan, State Highway Engineer, Trenton.*

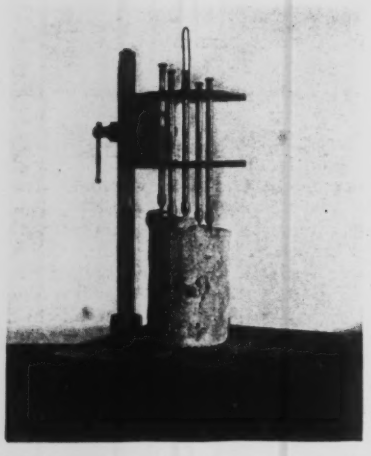
FROM FIELD AND OFFICE

Working problems and time-saving methods . . . Edited by Charles S. Hill

Average Core Length

by H. F. HEDDERICH
Superintendent Physical Laboratory, Indiana Highway Commission, Indianapolis

To obtain accurate average length of pavement cores with one irregular end is almost impossible by the use of a rule alone. The device illustrated obtains these measurements very satisfactorily. Five pins with hardened steel points bear on the irregular end of the core. The pins are graduated into tenths of an inch, and are so calibrated as to indicate the length of the core at the bearing point, by reading the graduation at the lower plate of the yoke which guides the pins. After taking one set of five readings the core is rotated 45 deg. and a second set of readings is taken. Since the pins are arranged with one on the center of the core and four on a diameter equal to two-thirds the diameter of the core, this method gives an average of ten readings, representing nine points on the core, the center point being represented twice. With this device two



Multiple pin device averages core length in less than a minute.

operators can check results on the roughest core within 0.1 in. The time required for measurement is from 30 to 60 sec. per core, including the averaging of the readings.

Each pin is graduated for a length of 2 in. which normally covers the range of all cores taken. If, however, a longer or shorter core is obtained the entire yoke can be moved on the graduated vertical post to accommodate this variation. The core is automatically centered beneath the pins by two angles bolted to the base plate. A light sheet metal plate with wire bail for hand-hold beneath the heads of the pins provides for raising all pins simultaneously to permit placing the core beneath them.

The tools of roadbuilding are in number far more than can be found in the market.

Job-made is a definition that can be applied correctly to innumerable devices that quicken the repeated tasks of the drafting and computing rooms, the laboratory and the construction operation.

A survey of highway progress in 1937 would be incomplete without representation from these fruitful fields of invention. Available space for text and illustration limits the possible representation: Only the testing laboratory and the construction job have been searched and of the many useful practices and devices found only a selected number can be presented here.

But "From Field and Office" in *Engineering News-Record* for 1938 will complete the list as the weeks go on and add many items to it.

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Mirror for Inspecting Culverts

by LEE V. SPENCER
Assistant Construction Engineer, Rhode Island Division of Roads and Bridges
Providence, R. I.

Once a year the R. I. Department of Public Works, Division of Roads and Bridges, makes a complete and thorough culvert survey. Among the conditions observed are: The invert condition; affected area inside; shape and deflection; joint condition, and number of cracks. In the case of a regular open-end culvert these conditions can be observed quite easily but when the drainage system is composed of catch basins and connecting pipes, the observations become more difficult especially when the basins are full of water and there are no means of climbing down inside.

For this work we developed a device consisting of a mirror mounted on the end of a wringer-mop handle. The handle is hollow and has a rod running through it. One end has the regular handle and the other end connects to the mirror so mounted that by moving the handle the mirror is adjustable to several different positions. When wishing to examine a pipe culvert connecting two basins, we first remove the covers from both basins, then hold the mirror down into either basin at the pipe connection and by adjusting the angle we can see through the pipe, providing it is straight of course, and observe the inside conditions. To get better vision it aids considerably to focus a flash light onto the mirror.

A mop-handle mirror for culvert inspection.

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Hints for Asphalt Testers

The active testing laboratory of the New Mexico state highway department is using a number of procedures and devices that are counting

up gains in speed and convenience. Three of these used in asphalt determinations are selected by B. E. Rutz, testing engineer, as being particularly useful.

1—To suit the volume of benzol which is required for the recovery of asphalt from asphalt structures, the laboratory varies the apparatus somewhat from that specified by Gene Abson in Proceedings A.S.T.M., 1933. Instead of first reducing benzol in a large flask so the whole will be contained in a 250-cc flask, a 500-cc wide mouth distillation flask is substituted for the 250-cc size and a wide-mouth separatory funnel with stopcock is inserted through the cock to allow the addition of the benzol-asphalt solution while the distillation is in progress. The procedure is otherwise as given by Abson as to temperatures, time and rate of gas flow; very satisfactory results have been obtained.

2—A method has been developed for adding a continuous supply of solvent to asphalt mixtures being extracted in the Dulin Rotarex for per cent bitumen determination and grading of extracted aggregate. Previously it was necessary to stop the Rotarex each time more solvent was added. With the continuous-supply method this is not necessary, and a more complete removal of the bitumen is effected with less solvent and in less time.

A quantity of solvent is added to the asphalt mixture when the bowl is charged and it is allowed to digest for a period of time depending on the material under extraction. The Rotarex is then started at a moderate rate of speed (700 r.p.m.) and a continuous stream of solvent (70 cc per min.) is fed by gravity from an overhead supply tank into the bowl by a $\frac{1}{8}$-in. copper tube with valve which connects with a 3/16-in. copper tube fastened securely to the center of the lid on the Rotarex and extending well down into the hole in the bottom of the funnel on the bowl. The handle for removing the lid is moved to one side.

3—A rapid method for determining whether an asphalt or asphalt oil has been overheated or cracked in the refining process has been discovered, that is suitable for either laboratory or field use. Ten grams of the asphalt or asphaltic oil under examination is dissolved in 100 cc of (84–86 deg. Bé) petroleum ether. The solution is then filtered through an alundum cone and washed with additional petroleum ether until all soluble material is dissolved. It is then dried and the color of the residue noted. If the color is black, the material has not been subjected to cracking temperatures and will pass the resistance-to-oxidation test as described in the Kansas City Testing Manual, p. 693. If the residue is brown, however, the material has been cracked or overheated in refining and it will not pass the resistance-to-oxidation test.

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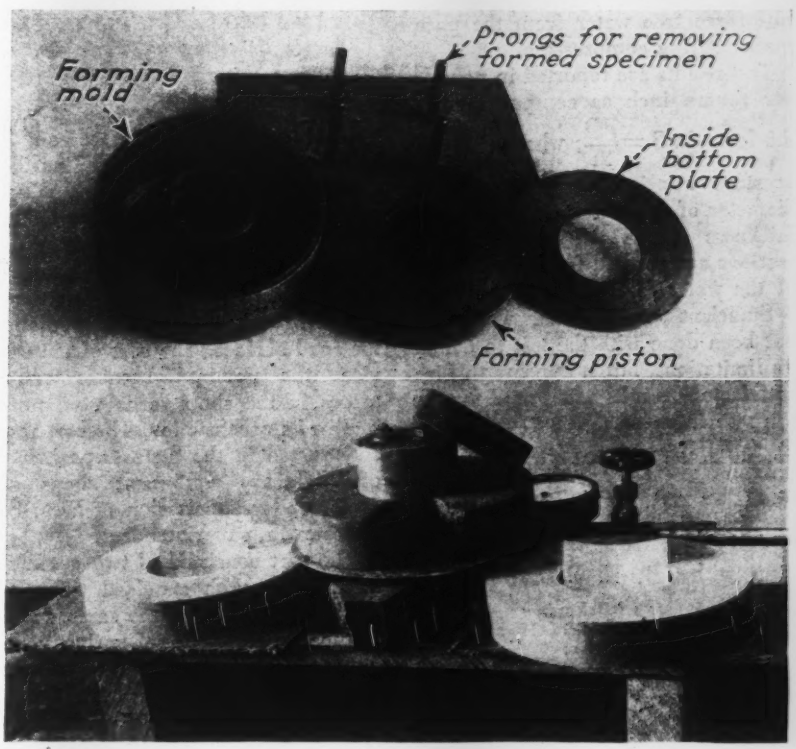
Measuring Pulverization of Filler Soil

by T. V. Bonher
Assistant Testing Engineer
Nebraska Department of Roads, Lincoln

In bituminous mat construction in Nebraska, it is nearly always necessary that filler material be added to the aggregates used so that sufficient stability is developed to withstand the loads to which the mat will be subjected. In choosing a natural-soil filler a number of factors must be considered, one of which is the ease of pulverization during the mixing operations. Part of the effectiveness of the filler material is lost unless the aggregations of soil particles can be well broken down.

Two tests have been used in the past and are still being used to evaluate this characteristic; one is the cementation test which is a modification of the method given by the A.S.C.E. for rock-bound macadam and the other is the plasticity test given in the A.S.H.O. "Methods of Tests." These two tests, although usually sufficient, cannot always be correlated with results obtained in the field.

It was thought that some test which would be indicative of the tensile strength or bonding with the varying percentages of moisture, might supply additional information relative to the case of pulverization during the mixing operations. Accordingly, the following test has been devised to obtain a relative measure of this characteristic. Reference to the accompanying illustrations will show the basic principle so that only a brief description will be given. The



Apparatus for testing pulverization of soil; top, parts used in molding specimens; bottom testing device showing broken specimen.

apparatus consists of a water-tight chamber with an elastic rubber diaphragm which fits inside a premolded ring of soil. By applying water pressure to the inside of the chamber the pressure is transferred to the inside of the soil ring so as to cause rupture. The stress produced is chiefly that of tension and may be measured by attaching a suitable pressure gage.

Two modifications have been made in the apparatus since the pictures were taken. A mercury gage 60 in. high has been connected to the chamber with a check valve between the gage and the chamber. A new forming-mold has been machined so that the soil ring has a thickness of 1 in. and a height of 2 in. rather than a thickness of 2 in. and a height of 1½ in. as shown.

Briefly, the procedure consists of forming several specimens with different percentages of moisture. The specimens are molded under pressure in a compression machine to the same density. Samples to determine the exact moisture content at the time of testing are taken from the ruptured soil rings. It is necessary to maintain the moisture contents between the minimum required for molding and the maximum which will force free water from the pore spaces during compression.

Test results are reported in pounds per square inch as computed from the formula $S = \frac{PD}{2t}$; where P is the pressure applied, D is the inside diameter of the soil ring and t is the thickness of the soil ring. No corrections are applied for the thickness of the walls of the specimen.

Sufficient experimental work has not been done with the test to define its limitations, but it appears to give satisfactory results when used for the purpose intended.

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Piles Cut by Blasting

by B. F. Perry
Junior Civil Engineer,
New York Division of Highways,
Rochester

The piles which supported the falsework during the erection of a bridge, of which the writer had charge, had to be removed at stream bed elevation at the completion of the job. The water being 10 ft. deep, the following scheme was hit upon and proved highly satisfactory:

About a half a stick of dynamite was placed in a short piece of old fire hose, 3 to 4 ft. long, and the ends of the hose were tightly sealed with clay. The hose, with its charge, was then loosely wrapped around the pile and dropped to the bottom of the stream. When the charge was fired, the pile broke off cleanly at the desired point and floated to the surface.

Incidentally, permission to do this was obtained from the State Conservation Department who had a game warden on the spot during operations. All fish killed or stunned by the shock, were gathered up by him and given to state or county institutions.

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Hand cart speeds laying of cotton fabric on road surface.

Cotton-Laying Cart

by Fred G. Greulich
Nevada Department of Highways,
Reno

In building a trial section of cotton-fabric-reinforced surface on 3 mi. of the Pyramid Lake road northeast of Reno, Nev., the cart illustrated was used to spread the cloth.

While simple and roughly constructed the cart was found to be more efficient and more rapid than is rolling the cotton directly along the road surface. The cost of the device was nominal because extra pieces in the shop yards were utilized in its construction. The cart was constructed in the State Department of Highways equipment shops at Reno, under supervision of Wm. S. Holesworth, superintendent.

The cart consisted of two automobile wheels with standard tires attached to an axle of the same width as the automobile. Leaf springs, one on each end, were fastened to the axle; on these was mounted a rough board platform with a tongue extending forward by which one or two workmen could pull the cart.

On the rear of the platform was bolted a wood cross-piece slightly longer than the cotton fabric roll, and at each end of the cross-piece was fastened an upright with a U-groove cut in the top. A steel pipe or rod, set in the grooves, formed a spindle on which the cotton-fabric roll weighing 150 lb. was mounted. The ends of the roll were protected by metal shields placed on the spindle at each end inside the uprights. A little grease placed in the U-receptacles made the spindle turn easily to unwind the cotton from the roll when the free end was placed at the selected starting point and the cart was pulled forward by workmen.

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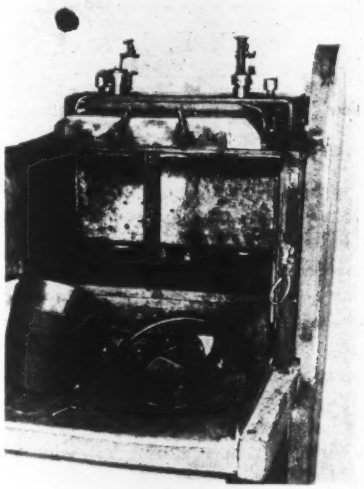
Asphalt Mixing Machine

by Ernest Zube
Assistant Physical Testing Engineer,
California Division of Highways,
Sacramento

A small device for mixing bituminous paving samples is in use in the California state highway testing laboratory. The large number of test specimens handled required the full time of at least one man when mixed

by hand. To relieve this pressure, and to assure uniform treatment of all materials, a mixer was designed and built in our machine shop.

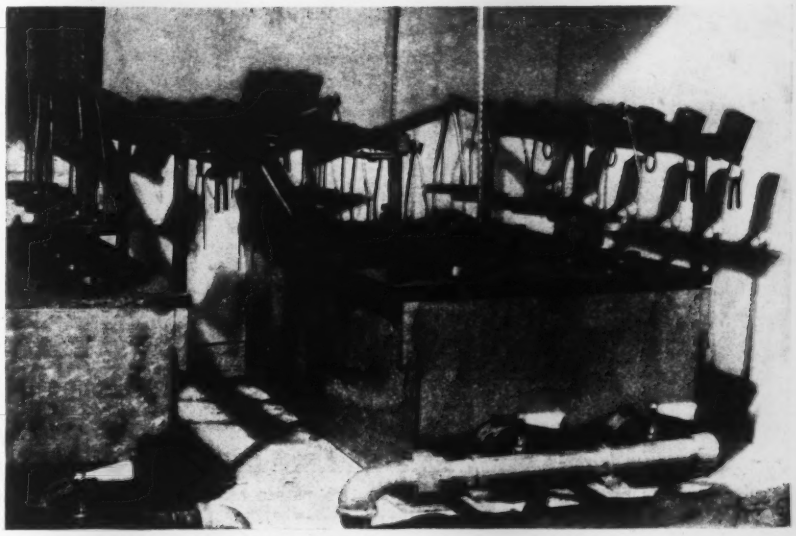
The mixer consists essentially of an insulated metal box, about 18 in. long, 12 in. wide and 12 in. high. Two removable metal containers 6 in. in diameter and 6 in. high are placed within the cabinet and held in place by bayonet locks. Each container is provided with a propeller-like paddle which is rotated by a vertical shaft at a speed of about 13 r.p.m. The shafts are driven by a worm gear and belt reduction from a ¼ hp. electric motor. An automatic mechanical timing device permits setting a predetermined number of revolutions for mixing, up to 200. Generally 100 revolutions are sufficient to mix the sample thoroughly. Peekholes on top and a small electric light placed on the inside enable the operator to observe the mixing.

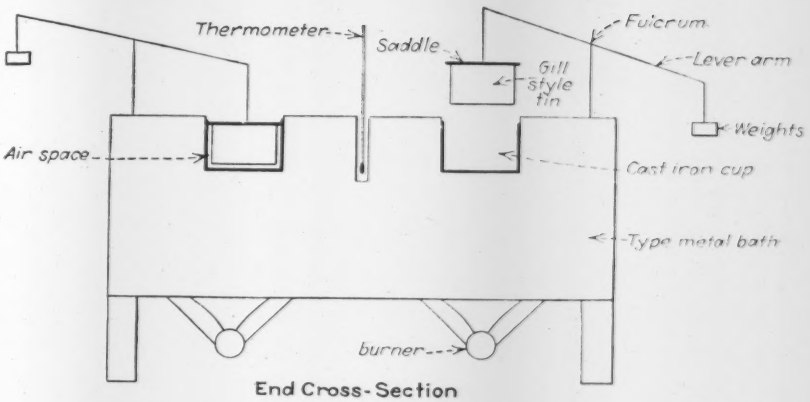


Mechanical mixer is a labor-saving device in preparing asphalt mixes for testing.

The capacity of the mixing bowls is about 1500 grams each and they may be operated independently. The mixture of aggregate and bitumen is proportioned by weight in a scoop-shaped pan to permit an easy transfer to the mixing bowl. A multiple unit electric hot plate provides temperature control.

This mixing machine has been in operation for a number of years, and due to its simple and sturdy construction, its maintenance has been negligible. As a labor-saving device it has paid for itself many times.





Device for multiple tests of asphalt samples for residue of prescribed penetration.

Test for Asphaltic Residue

by FRANK E. KINSMAN
Materials and Research Department, California Division of Highways, Sacramento

The apparatus illustrated was designed by members of the staff of the testing and research laboratory of the state of California to facilitate the performance of the test for the percentage of residue of a specified penetration. With it, it is not necessary to have a thermometer in the sample being tested, because by maintaining the type metal bath at a temperature of between 660 deg. F. and 680 deg. F. the temperature of the oil being tested remains at between 480 deg. F. and 500 deg. F.

The main feature of the apparatus is that it is automatic. By placing the proper weights on the end of the lever arm the material being tested is automatically removed from the bath, as soon as it has evaporated to the desired weight. The unit can be built to any size desired, depending entirely on the volume of work. In our laboratory we have two machines with a capacity of twelve samples each. With these we have been able to double our output of tests, at the same time expending only half the time required by the standard method. The equipment in every respect conforms to the A.S.T.M. standards.

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Novelty in Road Grading

A ten-mile stretch of state road south and a little west of Joliet, Ill., has interest as a dual road planned for stage construction. The part completed this year is one-half the final width, except that bridges and culverts are completed to full width. The construction was by contract,

A subgrading machine prepared subgrade in two passes along the road each pass grading a one-lane width.

one contractor building 6.2 mi. and the other building 4 mi. In general high-type roadbuilding plants were used on both contracts and all usual machine operations were mechanized.

The novelty in machine work was introduced by one of the contractors in subgrade preparation. A machine, called a utility grader, consisting principally of a bucket conveyor and a belt conveyor, the former operating longitudinally with the roadway and the latter transversely, excavated the subgrade accurately enough so that forms could be set with practically no hand excavation.

The bucket conveyor system moves across the roadway on wheels which ride on accurately-set track, this track having the same contour as the finished subgrade and being maintained parallel to it by power-operated hydraulic jacks mounted between the framework of the machine and the caterpillar chassis. The whole grader moves forward at a maximum speed of about 5 ft. per min. and has an average working speed of about 3½ ft. per min.

The hydraulic jacks are raised or lowered to keep targets, set at each corner of the machine, on a string line that previously has been set at a specified distance above finished grade. The bucket conveyor discharges onto the belt conveyor which conveys excavated material either onto the shoulders or into trucks. The movement of the belt conveyor can be reversed to discharge material from either side of the machine.

A rough-grade crew graded the roadway 2 to 3 in. high in the center to provide drainage prior to paving. A 10-man crew, composed of one utility grader operator, one helper, two form setters, three form setters' helpers, two subgrade laborers, and one subgrade roller operator, then turned this rough-graded roadway into finished condition. While being observed for an hour or so, this crew and machine prepared the subgrade so well that but one minor correction was necessary to place 300 lin. ft. of forms in alignment.

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Fast Solubility Apparatus

by HERBERT N. T. BOWDEN
Materials and Research Department,
California Division of Highways,
Sacramento

To expedite solubility tests the California highway testing laboratory makes use of a compact apparatus in which the filtration of several tests may proceed at the same time.

The accompanying view of the apparatus will explain the construction. Considering one unit: A 3-in. glass funnel is set in a vertical ¾-in. brass tube having a stop cock at the lower end. As is shown by the illustration a number of these vertical elements are set into a common horizontal ¾-in. brass tube connected by copper pipe to a receiving chamber that is in turn connected to an ordinary faucet filter pump. The stop cocks enable control of individual tests. All the construction is simple but care must be given to make air-tight connections to prevent loss of vacuum.

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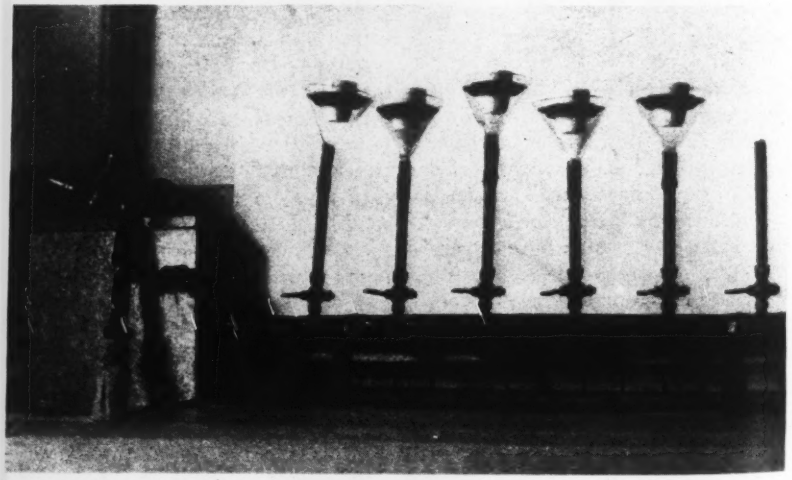
Trunk for Shipping Test Specimens

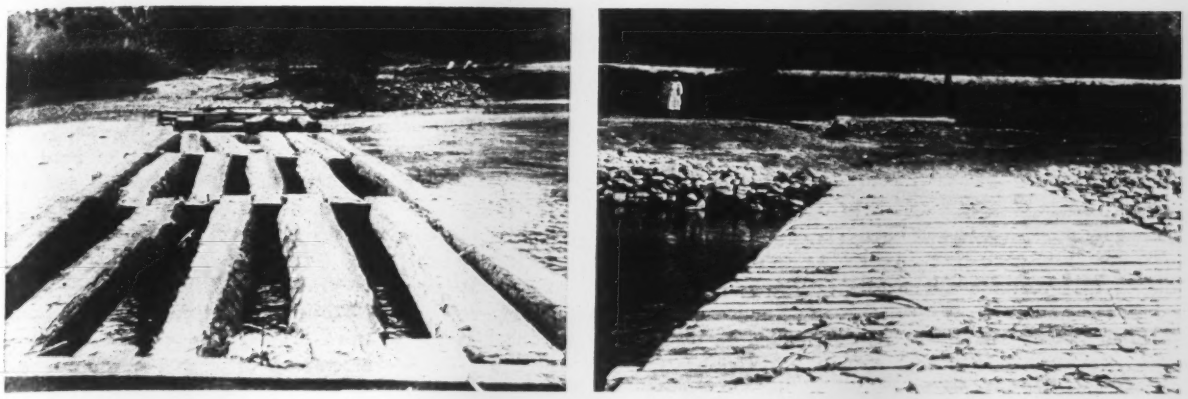
by B. E. RUTZ
Testing Engineer,
Bureau of Minerals,
New Mexico State Highway Department,
Las Cruces

The New Mexico state highway laboratory has designed its own express case for shipping concrete field specimens to the laboratory. Unlike the usual case, which is heavy, awkward and requires the services of two men to handle, the new case is light in weight, extremely sturdy, can be handled with ease by one man and is easily packed and unpacked.

The case is rectangular, with inside dimensions of 13½ in. wide 7½



Apparatus for making several solubility tests at one time.



Floor and stringers of low-water road bridge.

Low-Water Log Bridge

by H. E. McCLINTOCK
Civil Engineer,
Kansas City, Mo.

Replacement of a ford across Spring River near Hardy, Ark., with an overflow bridge of hewn logs in 1937 opens up a better route from an active cotton growing territory. The floor and stringers illustrated are carried on 20 log piers and a stone-filled crib. The piers are 30-in. sycamore logs hewed flat and drift bolted to the soft rock bottom by 1¼ in. x 7 ft. rods driven full length. On these are laid six stringers 14 x 18 in. laid flat and drift bolted to the piers with ¾ in. pins. The floor of 3-in. oak plank spiked with 80-d. spikes is 12 ft. wide with a down slope of 8 in. toward the upstream side; the low water clearance is about 12 in. below the stringers.

Spring River rises from the ground at Mammoth Springs some 20 mi. to the northwest; in times of flood it may rise 10 ft. and attain a velocity of 10 mi. per hour. The plan is that floods will top the bridge; as they run out in four or five hours the delay is not serious.

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in. deep and 20 in. long, to accommodate three 6x12-in. cylinders packed horizontally. A 4½-in. chest handle is fastened to each end. The lid is hinged and fastened shut with a hasp and a harness snap is used to keep the lid closed, the snap being securely fastened to the box by a short piece of chain. Heavy wood screws are used amply throughout the construction of the specimen trunk.

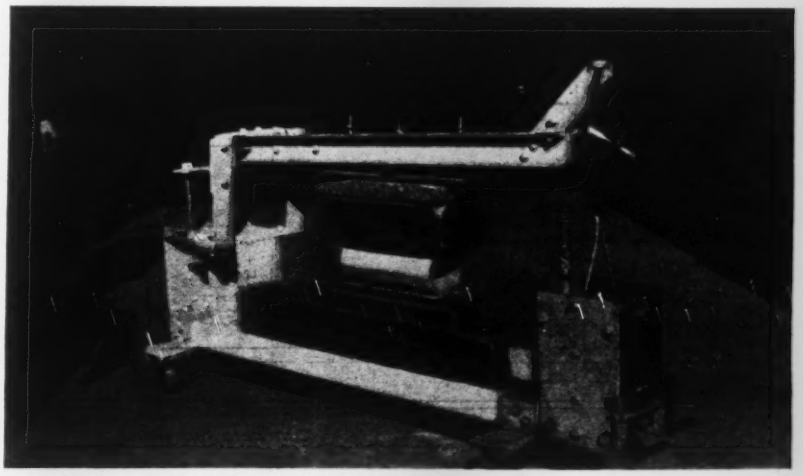
The pieces on the end are 2x8-in., while all other lumber is 1x8-in. material. Near the ends, strap iron bands ⅛x1⅛ in. reinforce the wood, extending across the bottom and up both sides. Inside on the bottom at one-third points are 2x4s, beveled on each edge, serving to reinforce the bottom of the box and also to hold the specimens securely in place. The box is painted with two coats of good quality paint and the laboratory name is stenciled on both sides so that there should be no trouble in identification.

The cylinders are packed in wet cement sacks and keep moist, even in this semi-arid climate, for at least a week; specimens are easily lifted out by means of the cement sack wrapping.

Tiles or Beams Tested

by R. R. LITEHISER
Chief Engineer, Bureau of Tests,
Ohio Department of Highways,
Columbus

Simple machines for testing concrete beams in the field to determine when it is safe to open concrete pavement to traffic are common. One that serves the dual purpose of breaking sample beams and of finding the crushing strength of drain tile is however something that is perhaps novel. The illustration shows the machine with a tile in place to be tested. The beam machine was changed slightly for tile testing. The moment arm which had a ratio of 5 to 1 for concrete beams was changed to a ratio of 2 to 1 for drain tile. Since the dynamometer has a capacity of 1000 lb., the machine then has a capacity of 2000 lb. which is ample for all ordinary drain tile that will fit into the machine.



This field beam-testing machine will also test small drain tile.

Three Job Aids Sketched

by R. H. Wood
Kansas Highway Department,
Cottonwood Falls, Kan.

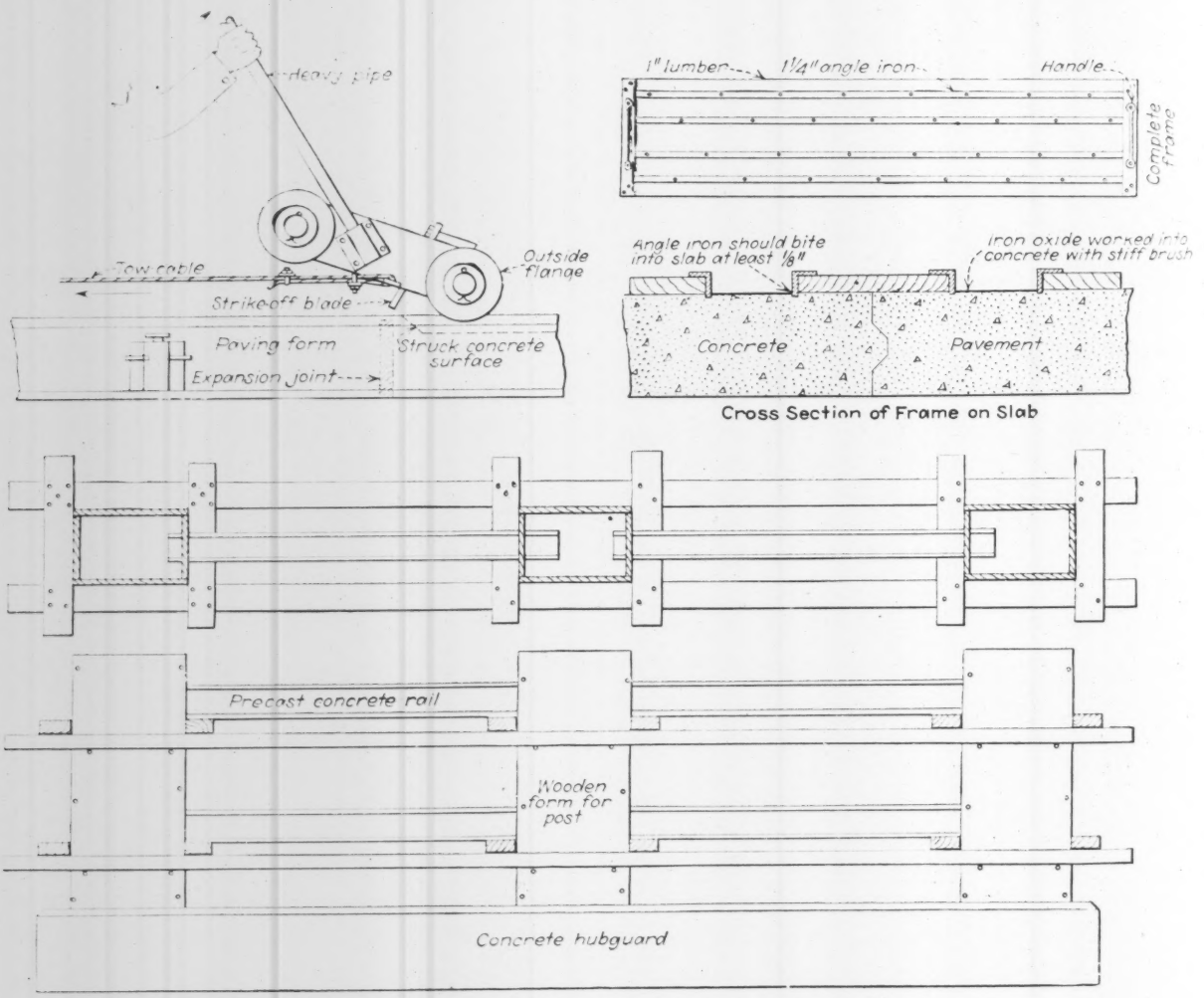
In telling about little devices that do a big service the engineer can often talk more clearly with his pencil than by stringing words together. Therefore this story is told in sketches and just enough words to explain the pencil lines.

Tilting Strikeoff Bridge—The first sketch illustrates one end of a paving strikeoff bridge equipped with heavy pipe handles so that it may be easily tilted to clear expansion joints. This arrangement eliminates the clumsy form-bridges usually employed and which so often slide or upset with injury to the joint and loss of mixer time. The concrete is also struck off much nearer the joint greatly facilitating the placing of the wire mesh. When properly balanced and rigged two men can easily tilt a very heavy strikeoff in this manner.

A Striping Form—The second sketch illustrates a template or striping frame used with much success in placing a double iron-oxide center stripe on fresh pavement. The principal feature of this frame is the angle iron reinforcing which keeps the frame straight and rigid. It was found that by letting the vertical flanges on the angle irons bite into the slab surface about 3/16 in. a very neat stripe could be obtained.

The groove thus made on each edge of the stripe disappeared when the frame was lifted without disturbing the exceptionally clean cut edge on the stripe. It was not found necessary to sharpen the protruding edge of the angle iron. This frame was found to work equally well with liquid or powdered coloring material.

Guard Rail Post Form—In constructing concrete posts and rails for bridges and culverts much difficulty is often experienced in setting individual forms true to line and grade and in holding them true until the concrete has been poured and has taken its set. However, when post-forms for a complete panel are fastened together as a unit this difficulty is eliminated. A good method of assembling a panel is illustrated in the third sketch. The yokes are readily assembled of 2 x 4-in. lumber and should fit the post forms snugly. The concrete rails are supported on the cross ties insuring the same grade on opposite sides of a post. The yokes may be supported on nails driven directly into the forms or by struts running up from the hubguard. Shims and wedges can be used for adjustments as when individual panels are used.



Three devices that will ease the burden of the field worker on road construction

Sources of Road Revenues

Increase of over 10 per cent in gas-tax and of 3 per cent in motor-vehicle-tax collections in 1937 indicate more money for 1938 roadbuilding

THE larger highway budget for 1938 is based on the solid foundation of increasing revenues in 1937. A 9½ per cent gain in gasoline tax collections is indicated for the year by preliminary unofficial figures assembled for this issue by *Engineering News-Record*. This estimate seems highly conservative since the estimate for the year made by the National Petroleum Institute and based on 7 months' collections, predicts a 12½ per cent gain over 1936. The motor-vehicle revenue gain indicated by the *Engineering News-Record* survey for 1937 amounts to 3 per cent over that of the preceding year.

Diversion to continue

Diversions for non-highway use from gasoline-tax and motor-vehicle funds increase in like measure in several states, but promise to be lower in a few, notably Indiana, Nebraska, North Carolina, Oklahoma (diversion stopped June, 1937), South Dakota and Wisconsin. Judging from the incomplete data now available, total diversion for 1937 may be only slightly higher than in 1936. Michigan reversed the diversion procedure by diverting $5,000,000 from state general funds to highways.

Revenue at new high

Revenue collected in 1937 from highway users reaches $1,458,000,000, a new all-time record. This total is made up of federal excise taxes, $338,000,000; of gasoline taxes, $750,000,000, and of motor vehicle and related fees, $370,000,000. How this revenue compares with previous years is shown by Fig. 1, which illustrates also the extent to which these three funds have superseded other means of financing highways. It may be expected that this highway user revenue will be distributed, 65 per cent to states, 21 per cent to county and other local and municipal authorities and 14 per cent to non-highway purposes. This distribution is estimated on the basis of 1936 percentages and not on 1937 statistics.

Diversion low in 1931

In 1931, diversion to non-highway purposes took only 2.4 per cent of the revenue collected by states from highway users. This percentage rises steadily each year to 16.2 per cent in 1935, 16.6 per cent in 1936 but promises to taper off, in the higher 1937 revenue, to 14 per cent.

Since 1933, the federal government, too, has collected more money from highway users than it has paid back into highways. In the 10-year period, 1927–36 the federal government paid into highways $368,000,000 more than it collected from highway users. However, in the preceding 10 years, 1917–26, it collected $538,000,000 more than the $510,000,000 it paid out for highways. Thus, on its 20-year record federal imposts on highway users have exceeded by $170,000,000 federal payments to states for highways, 7½ per cent of total collections.

Over the 10-year period, 1927 to 1936, states have diverted for non-highway purposes, $690,000,000 out of funds collected from highways users, 13 per cent of total collections. The indications for 1938 are that this rate may be expected to continue.

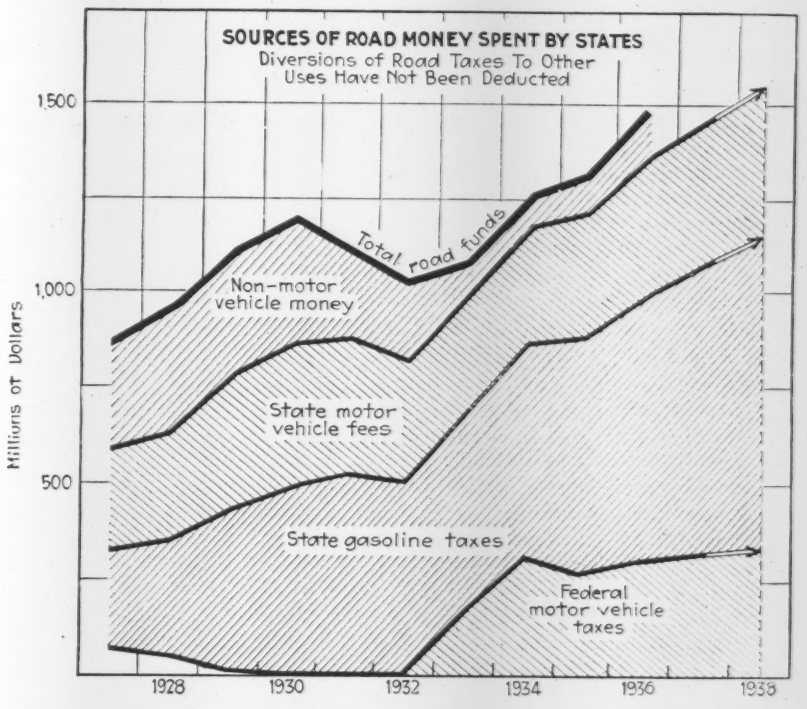


Fig. 1. Highway users in 1937 paid $1,458,000,000 to state and federal tax collectors, an increase over 1936 of about 10 per cent.

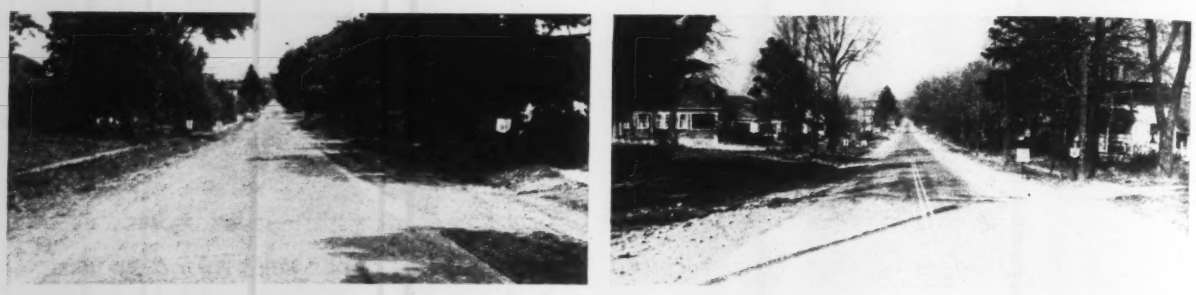


FIG. 1. OLD 16-FT. BITUMINOUS PAVEMENT IN OHIO IS REPLACED WITH 20-FT. WIDTH.

Resurfacing Expenditures Increase

On main roads mostly, but on all state roads, more construction money is going to the revamping of obsolete surfaces

STATE HIGHWAY SYSTEMS are beginning to show their age, and replacements now take 67 per cent of the highway budget, whereas surfacing on non-surfaced roads take only 33 per cent. We have the figures for 1936 only but state highway departments report more resurfacing in 1937 and more to come.

In 1936, 28,913 miles of surfacing was built on roads under state control. Of this total, 67 per cent replaced old surfacing either with the same type or with a different type. Assuming that the different types of surface represent betterments, 29 per cent of the 1936 surfacing maintained the existing status of improvement, 38 per cent went into betterments, and only 33 per cent added surfaces in non-surfaced roads. The replacement percentage is even higher on the primary system alone, 75 per cent for replacements and betterments, 25 per cent for added surfacing on non-surfaced mileage.

How much of their mileage the states had to build in 1936 to stay in the same place as to status of improvement is illustrated graphically by the left hand bars in Fig. 1. The right hand bars show betterments and additions.

Interest naturally turns from this over-all picture to how the various individual types of surfaces are affected by replacements and betterments. The highest ratios of surfacing to replace the same type are in the top soil, untreated gravel and brick or block classes, Fig. 2. High ratios of replacement of different type surfaces are also shown for treated gravel, treated macadam, low-cost bituminous, bituminous macadam, bituminous concrete and sheet asphalt. These high ratios for treated mileage replacing other types of surface undoubtedly reflect planned stage construction.

Portland cement concrete leads the new high type surfacing on non-surfaced roads. Untreated gravel and untreated macadam show the highest ratios for the new low type surfacing on non-surfaced roads.

State highway systems are in a transition period. Age of the original system accounts in large measure for the high replacement needs. But the addition by 14 states of secondary highway systems has added raw and semi-improved mileage that means more stage construction and the need for more new surfacing on non-surfaced roads.

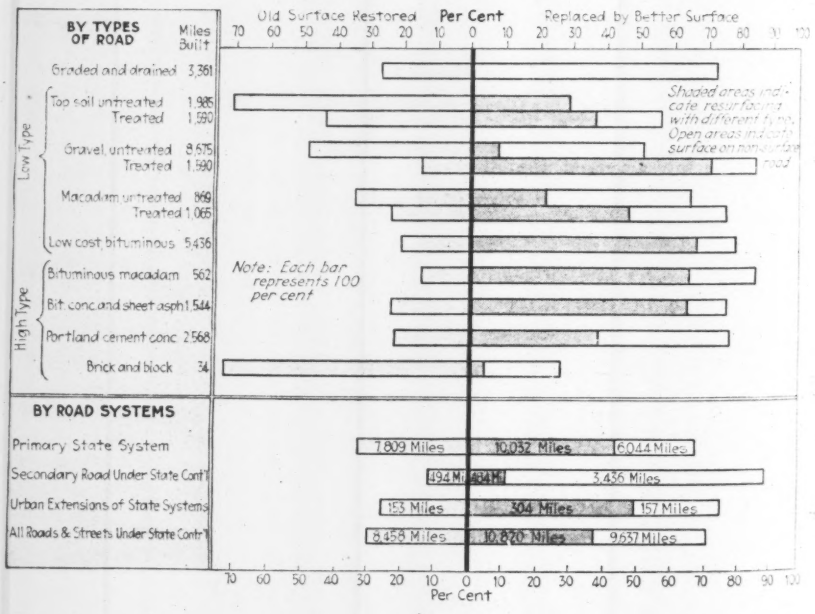


Fig. 2. In 1936, states built 29 per cent of their mileage to replace same type of surface, 38 per cent to replace different type, 33 per cent to add new surfaced mileage.

Needed Planning Begun

by H. S. FAIRBANK
Chief, Division of Information, Bureau of Public Roads, Washington, D. C.

In 1937 the highway departments of 45 states were engaged in making a uniform survey of road conditions, traffic service and means of financing that for the first time will provide a basis for long-time highway system planning

THE ENGINEERING OF HIGHWAYS begins with planning. Highway planning took a long stride ahead in 1937. Long advised and much talked about the purpose blossomed into action in 1936 that became widespread in 1937. During this last year in 45 states and the territory of Hawaii comprehensive highway planning surveys have been and now are in progress. In a few of these states the work was just begun last year; in many the various field observations were almost or quite completed, and the labor of analysis, necessary for the interpretation of the facts gathered, is well under way. All of these surveys conform to the general outline suggested about two years ago by the Bureau of Public Roads, and all are being actively prosecuted by the several state highway departments with the cooperation and advice of the federal bureau of roads.

The surveys go far beyond the usual traffic survey in their search for facts. First, the traffic surveys are included—surveys that seek to establish the relative flow of traffic on all rural roads—not merely on the state highway systems to which all previous efforts have been confined. Moreover, these surveys aim not simply to determine the volume of vehicular movement, but also its origins and destinations, its purposes and precise character, and the relative demands it makes upon all roads by reason of the weight of its units as well as their numbers. Joined with the studies of traffic, there is a complete inventory of all rural road facilities. Finally there is a financial investigation. The three interrelated groups of studies, taken together, are designed to supply all of the facts necessary for a review and a revamping of current highway policies and practices to fit them more closely to the present need.

So much for the character of these surveys, which far excels anything of previous record. The processes and equipment employed are similarly far ahead of any previously in use. But why all this effort at fact-finding? The reasons are found in the present conditions of highway development. Let us look at conditions and reasons.

The roads now

By the steady application of state and federal efforts to the improvement of the limited federal-aid and state highway systems, these main rural arteries have been improved to a degree that permits a heavy traffic to flow between cities, states and regions from end to end of the country. That the improvement is not wholly adequate is a matter of common report; but precisely what shall be done to make it so, what will be the cost of the further improvement and how such costs are to be met are questions that await satisfactory answers until more facts are determined.

While the main roads have been in process of improvement to their present admittedly inadequate state, the lesser rural roads have been variously improved through the uncoordinated and sometimes misdirected efforts of thousands of local, county and township authorities. Even the mileage so improved is unknown; and as, with unimportant exceptions, there has never been a traffic count on these roads, there is now nothing but the probably fallible judgment of local elected officials to give assurance of the adequacy or the need of the improvements that have been made.

No one now knows with any degree of accuracy what part of the whole rural highway traffic movement is served by the roads that have been thus far improved by the federal, state and local governments. It is roughly estimated that somewhat over 1,000,000 mi. of the 3,000,000-mi. total of rural roads have been improved. It can reasonably be assumed that improvement of the whole mileage will be neither necessary nor financially possible, but whether the mileage already improved is near or far from the mileage that ultimately should be improved to afford a justifiable service cannot be said until the current surveys supply the yardstick for measuring need and road condition.

Time for a change

It has been reasonable thus far in the nation's roadbuilding to deal *in parts* with the improvement of the highway system. The special and concerted attention given to the important part that comprises the clearly distinguishable main arteries has been justified by the greatly superior need for its improvement. The more casual and disjointed improvement of the lesser roads has been tolerable as the best that could be expected under the existing circumstances. The stage construction policy, with its implication of temporary acceptance of improvements known to be less than fully adequate, was the best answer possible in a situation in which the minimum need for improved mileage far exceeded the accomplished improvement. But time and continued construction have now brought nearer the realization of what complete adequacy means.

It is clear that at the lower end

of the scale of road utility there is an approach to the margin beyond which improvement may not be economically extended; also on the main roads it is equally clear that the point has been reached where (a pioneer improvement completed) subsequent betterments, many of them necessarily radical and expensive departures from the existing designs, must aim as nearly as possible to meet ultimate or long-time needs so that future obsolescence may be held within reasonable limits. For the improvement of more and more of the local road mileage there is an optional demand, politically expressed, that does not stop short of an all-year road to every farm.

Where the survey helps

The extent to which these improvements can actually be carried out rests upon the willingness of the public to pay not only for their initiation, but also for their perpetuation by maintenance, reconstruction as needed and continuation of the many and increasing services necessary for the operation of a modern highway system. And there are marked signs of reluctance to pay.

Obviously the tendencies toward reduction of revenue are incompatible with the growing demand for expenditures on both the main and the local roads, and the steadily increasing cost of maintaining the expanding improved highway system. Clearly, the demands and needs must be brought into balance with the obtainable resources, and that quickly, and this calls for facts. And in the process of adjustment it is important that there shall be a new definition of the proper contributions of the several branches of government (federal, state and local) which will be maintained without abrupt change for any but the most compelling reasons, and again facts are necessary.

Coupled with this pressing problem of the essential adjustment of highway revenue to highway need, there is the equally urgent necessity for a rational revision of the laws of the state and federal governments regulating the use of the roads. In their effects upon the weight, size and speed of vehicles, these regulations fix or should fix the standards of road design. It is important that they be adjusted to demonstrated economic need and, when so adjusted, that they be really enforced so that roads built in accordance with them shall be protected against illegal and harmful usage. It is highly important also that the existing illogical variety of regulatory measures in force in the various states be reduced to a closer harmony consistent with actual economic needs of the area served.

The highway planning surveys are collecting a wide variety of data in 45 states which, when compiled and analyzed will for the first time permit intelligent and satisfactory answers to be given to the important fundamental questions outlined.

More Road Accidents

by SIDNEY J. WILLIAMS

Director Public Safety Division, National Safety Council, Chicago, Ill.

Despite an increase in accidents, gasoline consumption shows lower rate of mishaps per 10,000 miles

MOTOR-VEHICLE-ACCIDENT deaths on American streets and highways will reach a new high in 1937, probably close to 40,000. In addition, about 1,250,000 personal injury accidents will be charged to 1937, as will four or five million property damage accidents.

And yet, one could drive 10,000 miles in 1937 with less likelihood of accidents than in any previous year.

First, the percentage increase in deaths and injuries in 1937 over 1936 was less than the percentage increase in gasoline consumption and mileage traveled (for the first 10 months, 8 per cent against 9 per cent). Similarly, the percentage increase of deaths in 1936 over 1935 was less than the increase in mileage.

Second, and more significant; despite the increase in travel more than one third of the states and many large and small cities showed an actual reduction in deaths during 1937. (On latest data, 20 states and 33 of 82 large cities reporting). A number of states and cities, with no natural advantages, achieved reductions in their traffic death rates of 50 per cent or more below average.

Open winter blamed

Third, most of the 1937 increase took place in the first three months, due largely to a more open winter and more travel under hazardous winter conditions. The last five months, June to October inclusive, showed a 2 per cent increase in deaths against a 10 per cent travel increase.

The past year brought further recognition among highway engineers that the only safe trunk line construction is a four-lane, divided highway with no grade crossings of either a railroad or another highway. Standard practice also recognizes longer sight distances, substantial 8-ft. shoulders, center line and even lane markings visible both night and day on curves and sometimes on tangents, and uniform standard signs and signals, including stop-and-go signals at important crossings in the country as well as in town.

The increasing night accident hazard has come in for much discussion. There is a growing realization that while highway illumination is bound to come on heavily traveled stretches and at other danger points, the great majority of highway and street mileage must be made reasonably safe for night travel by other means. Among these are better automobile headlighting, center markings, visible signs, pedestrian islands and perhaps lower speed limits in the open country at night.

During 1937 there was a tremendous surge of traffic safety legislation; legislatures in 10 states added standard drivers' license laws to their statutes, bringing to 30 the number of such measures now effective in the United States. Several other states overhauled sub-standard laws to put more teeth in them for the control of drivers. Only six states are without any manner of drivers' license law.

THE WEEK'S EVENTS

(Continued from page 45)

Dam Builder Retires From Aluminum Co.

James W. Rickey, chief hydraulic engineer of the Aluminum Co. of America, who has had charge of construction of all the hydro-electric plants of the company built since 1907, retired from his position at the first of the year. All of the company's dams and power plants, with the exception of the relatively small Niagara Falls and Massena, N. Y., plants, were built during Mr. Rickey's term of service. Mr. Rickey is succeeded by James P. Growdon, who has been his principal assistant since 1925. Because of his intimate knowledge of the company's power plants, Mr. Rickey has agreed to continue as consulting engineer for the hydraulic department.

Mr. Rickey, who was born in 1871, graduated from Rennselaer Polytechnic Institute in 1894 and went to work in the office of the division superintendent of the Northern Pacific R.R., Minnesota division. Two years later he left that position, and, after a year's service as first assistant engineer for the Lake Superior Power Co., he joined the St. Anthony Falls Water Power Co. as principal assistant engineer, working on construction of hydro plants and appurtenant structures. In 1907 he took the position of chief hydraulic engineer for the Aluminum Co. which he held until his present retirement.

Mr. Growdon takes over Mr. Rickey's duties after 13 years as his assistant, at the age of 54. Mr. Growdon had his first engineering experience in 1906 as a foreman on concrete bridge construction for the Chicago, Burlington & Quincy R.R. He then spent four years with the Washington Water Power Co. on construction, maintenance and operation of hydro-electric power plants. Then followed brief connections, on design and construction of hydro plants, with the Portland Electric Power Co. and the Pacific Power & Light Co. Service as superintendent of construction and distribution and later as assistant general superintendent for the Northwestern Electric Co. was interrupted by two years of war service overseas with the U. S. Engineers, which he left with the rank of major. In 1920 he became electrical engineer and assistant chief engineer for the city of Seattle on the Skagit River development, leaving the city's service in 1925 to join the staff of the Aluminum Co. of America.

Blackstone Studios

JAMES W. RICKEY

Auto Companies Plan Housing Development

A number of large housing programs for workers are being projected by auto companies. Apparently nearest the stage of actual construction is the Ford project. Ford plans the erection over a period of years of about 4,000 housing units for low and medium income workers. The project will be undertaken by the Ford Foundation, a non-profit organization, on a 1,200 acre tract in Dearborn. Mass production methods are expected to bring the cost of the houses down to about $2,500 each. Most will be single family structures, with a few apartment houses. It is believed that construction of the first section of the project will get under way in the spring.

General Motors and Chrysler are also reported to be interested in housing. *American Machinist* reports that General Motors is planning a new housing development of several hundred units at its diesel plant, well out of the center of Detroit, and about 100 low cost houses at Pontiac. General Motors itself is not sponsoring that development but is said to be cooperating.

At Marysville, Mich., site of the former Wills St. Clair plant recently taken over by Chrysler, *American Machinist* reports that an organization headed by Harold Wills, of the Chrysler Corp., is planning housing.

New Montreal Bridge Contract Let

Contract for the construction of a new highway bridge connecting the east end of the island of Montreal to the mainland has been let to the Dufresne Construction Co. of Montreal. The bridge will replace narrow plank roadways laid on the deck of Canadian National Ry. bridges, which have for years been the only outlets for vehicle traffic from the east end of the island. The new bridge will be a little downstream from the C. N. R. bridges, which will now be used only for railway purposes. In connection with a new section of the Montreal-Quebec highway, to be completed next year, the new bridge will reduce the present road distance between the two cities by about 12 miles.

The bridge, which will have a total length including the approaches of about a mile, consists of three reinforced concrete arches with spans of 110, 150 and 110 ft. It will carry a 40-ft. roadway and 10-ft. sidewalk and is to cost about $2,500,000. Preliminary work has already been started.

It was in anticipation of the award of contracts for this bridge that the Montreal Builders Exchange recently protested to the Quebec government against bidding procedures followed by the province in awarding contracts on recent public works (*ENR*, Oct. 28, 1937, p. 727), particularly the Pius IX bridge, on which the Dufresne company was also the contractor.

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Montreal Must Pay Damages For Not Building Sewer

Damage claims totaling $70,000 were awarded last month against the city of Montreal by the Superior Court at Montreal in 70 cases arising out of flooding from the Back River due to the fact that the city had not started construction of the Henri Julien trunk sewer. The floods occurred in the period from March 1936 to April 1917. The city admitted liability, but the amounts of the damages were taken to trial.

Contract for construction of the trunk sewer was awarded recently, but the Municipal Service Commission, a supervisory body in the provincial government of Quebec, has refused its approval to the contract award because of reported dissatisfaction at the way in which the award was handled.

The commission has also withheld its approval of the contract for reconstruction of the Cote Des Neiges service reservoir of the city of Montreal, which was recently awarded after some delay.

POWER PROJECTS IN LITIGATION DEC. 14, 1937

Project	Loan	Grant	Est. cost	Capacity Killowatts
ALABAMA				
Sheffield		$72,000	$230,000	
Decatur	$269,000	81,000	350,000	
Hartselle	33,000	27,000	60,000	
Russellville	69,000	56,454	125,454	
Guntersville	48,000	39,272	87,272	
Tarrant City	181,000	148,091	329,091	
Bessemer	481,000	757,182	1,238,182	
Courtland	16,000	13,000	29,000	
ARKANSAS				
Paragould	$100,000	$99,000	$200,000	1,000
CALIFORNIA				
Imperial I. D.	$1,518,000	$1,242,000	$2,760,000	14,250
IDAHO				
Coeur d'Alene	$277,800	$102,000	$729,000	1,500
ILLINOIS				
Centralia	$347,000	$130,000	$477,000	2,000
Jacksonville	231,000	189,000	420,000	2,000
IOWA				
Lamoni	$73,000	$24,000	$97,000	400
Hopkinton		30,000	56,000	200
KANSAS				
Hoisington	$82,500	$67,500	$150,000	670
KENTUCKY				
Middlesboro		$91,000	$328,000	1,280
MICHIGAN				
Bessemer	$103,000	$84,500	$187,500	600
Menominee	588,500	214,500	803,000	3,200
Dowagiac	145,000	57,000	202,000	900
MINNESOTA				
Glenwood		$67,909	$150,909	600
Eveleth	$291,000	125,000	845,000	2,500
Janesville		31,455	105,455	450
MISSISSIPPI				
Starkville	$64,844	$53,055	$150,909	
Aberdeen	63,000	54,000	120,000	
MISSOURI				
Trenton		$88,000	$315,000	1,300
La Plata	$71,200	28,800	100,000	400
Thayer	39,000	32,735	71,735	280
NEBRASKA				
Platte Valley	$7,585,000	$2,580,000	$10,165,000	25,000
Loup River	6,525,000	2,175,000	8,700,000	47,700
Tri-County	16,553,000	13,543,000	30,096,000	52,000
Columbus		180,000	430,000	
NEVADA				
Las Vegas		$112,909	$250,909	
NEW YORK				
New Hyde Park	$165,000	$135,000	$300,000	1,400
Plattsburg	286,000	234,000	520,000	1,800
NORTH CAROLINA				
High Point		$2,595,000	$5,766,750	24,900
OHIO				
Wapakoneta	$95,600	$50,400	$186,000	1,500
Columbus		320,000	1,125,200	10,000
Sandusky	1,085,000	430,000	1,515,000	6,000
PENNSYLVANIA				
Myerstown		$68,715	$152,700	600
SOUTH CAROLINA				
Greenwood Co.	$2,195,000	$657,000	$2,852,000	15,000
Santee-Cooper	5,775,000	225,000	37,500,000	15,000
SOUTH DAKOTA				
Flandreau		$76,000	$168,770	648
TENNESSEE				
Knoxville	$2,000,000	$600,000	$2,600,000	
Lewisburg	55,000	45,000	100,000	
Columbia	112,000	92,000	204,000	
Chattanooga	2,382,000	1,948,000	4,330,000	
Memphis		3,092,000	6,872,000	
Newbern	33,000	26,000	59,000	
Paris		135,000	300,000	
Lenoir City	29,000	23,727	52,727	
Jackson	364,000	299,500	663,500	
Fayetteville		67,050	149,000	
Clarksville		112,500	250,000	
TEXAS				
Lower Colo. R. A.	$10,500,000	$4,500,000	$20,000,000	67,500
Liberty	68,200	27,000	95,200	300
Leonard		32,727	72,727	150
Electra	122,000	99,818	221,818	600
VIRGINIA				
South Norfolk		$148,000	$331,000	1,500

CALENDAR OF MEETINGS

NATIONAL SOCIETIES

AMERICAN ROAD BUILDERS ASSOCIATION, road show and convention, Cleveland, Jan. 17-21

AMERICAN WOOD PRESERVERS ASSOCIATION, annual convention, Congress Hotel, Chicago, Jan. 18-20.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual meeting, New York City, Jan. 19-21.

NATIONAL RIVERS AND HARBORS CONGRESS, 33rd convention, Mayflower Hotel, Washington, D. C., Jan. 20-21.

PURDUE ROAD SCHOOL, annual school and road show, Purdue University, Lafayette, Ind., Jan. 24–28.

ENGINEERING INSTITUTE OF CANADA, annual meeting, London, Ont., Jan. 31-Feb. 1.

LIME PUTTY PRODUCTS ASSOCIATION, annual meeting, Netherland Plaza Hotel, Cincinnati, Feb. 1.

AMERICAN CONCRETE CONTRACTORS ASSOCIATION, National Concrete Masonry Association, National Cinder Concrete Products Association, Cast Stone Institute, joint convention, Hotel Sherman and Medinah Athletic Club, Chicago, Feb. 7-11.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, annual convention, Willard Hotel, Washington, Feb. 8-10.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS, annual meeting, Engineering Societies Building, New York City, Feb. 14-18.

ASSOCIATION OF HIGHWAY OFFICIALS OF NORTH ATLANTIC STATES, annual convention, Hotel Ambassador, Atlantic City, N. J., Feb. 16–18.

REGIONAL AND LOCAL

NEW YORK STATE SEWAGE WORKS ASSOCIATION, annual meeting, New York City, Jan. 20-22.

NORTH CAROLINA SOCIETY OF ENGINEERS, annual meeting, Raleigh, Jan. 28-29.

SOUTHWEST ROAD SHOW AND SCHOOL, annual session, Wichita Exhibition Building, Wichita, Kan., Feb. 22-25.

NEW JERSEY SEWAGE WORKS ASSOCIATION, annual meeting, Stacy Trent Hotel, Trenton, N. J., Mar. 10-11.

AMERICAN WATER WORKS ASSOCIATION, NEW YORK SECTION, spring meet-

ing, Hotel Jamestown, Jamestown, N. Y., Mar. 17-18.

ELECTIONS AND ACTIVITIES

ABEL WOLMAN was elected president of the Maryland section of the A.S.C.E. at the annual meeting early this month. A. H. Hartman was elected vice-president. Life membership certificates were awarded to John E. Greiner, Valentine S. Doebler, Warrick R. Edwards, Thomas D. Pitts, Alfred M. Quick, George E. Thackray, and Wendell M. Reed.

LIFE MEMBERSHIPS in the American Society of Civil Engineers were awarded Dec. 16 to the following members of the Central Illinois Section: Jacob A. Harman, Edward A. Hermann, Arthur N. Talbot, Frank H. Eno.

THE BRONX COUNTY Chapter of the New York State Society of Professional Engineers is sponsoring an essay contest for high school students on the subject "What Civic Improvement Would You Propose as the Most Beneficial to the Borough of the Bronx?"

ENGINEERING SOCIETIES of Springfield, Ill. voted at a joint meeting last month to form a Springfield council of engineering societies, composed of presidents and local representatives of all the societies in the city.

R. A. HART is the new president of the Utah Section of the American Society of Civil Engineers. Other new officers are: T. C. Adams and George D. Clyde, vice-presidents; F. H. Richardson, secretary-treasurer. Life membership certificates have been awarded to two members of the Utah section, Robert K. Brown and Herbert S. Kerr.

THE SAN DIEGO SECTION of the A.S.C.E. has elected the following officers: President, Clayton B. Neil; vice president, Paul Beerman; secretary-treasurer, Wayland Capwell.

THE SAN FRANCISCO SECTION, A.S.C.E., at the annual meeting last month, announced election of the following officers: President, Ralph G. Wadsworth; vice presidents, F. H. Fowler and H. B. Hammill. Thirty-one members of the section were awarded life memberships.

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License Examinations

NEW YORK: Examinations for professional engineers at New York, Albany, Syracuse and Buffalo, Feb. 1-3. Examinations for land surveying will be held Feb. 4.

CHAINING FUTURE FLOODS AT FORT PECK

STAINLESS steel hoisting chains will operate the sixteen huge floodgates at the head of the spillway at Fort Peck Dam. Here one of the long-boom cranes of the McKiernan-Terry Corp., of New York, contractor on the installation of the gate operating machinery, is lifting a chain into place above a gate. Installation of the gate machinery marks the finishing touch on the elaborate spillway control structure, construction of which started in 1935 with the boring of holes deep in the shale foundation for concrete caissons.

William Bowie Honored By Dutch

The Queen of the Netherlands has appointed Dr. William Bowie, retired chief of the Division of Geodesy of the U. S. Coast and Geodetic Survey, an officer of the order of Orange-Nassau. This honor is in recognition of Dr. Bowie's achievements in the interests of international science and geodesy and particularly his work in collaboration with Dr. F. A. Vening Meinesz, professor of geodesy at the University of Utrecht, in the determination of gravity at sea.

Dr. Meinesz, who was associated with Dr. Bowie in the work of the International Association of Geodesy, a branch of the International Geodetic and Geophysical Union, developed an apparatus by means of which accurate determination of the values of gravity can be made aboard a submarine. Dr. Bowie was twice instrumental in bringing Dr. Meinesz to the United States to head expeditions for the determination of gravity at sea on submarines of the U. S. Navy in West Indian waters.

Dr. Bowie at present holds honorary degrees from Trinity College, Lehigh University, George Washington University, and the University of Edinburgh, as well as honorary memberships in the Academies of Sciences of France and Norway, and the Russian Geographical Society.

Dr. Bowie was retired from the U. S. Coast and Geodetic Survey in December, 1936, after 41 years of service.

OBITUARY

OSCAR C. PICKEL, who served as a highway and sanitary engineer during the construction of the Panama Canal, died in Salt Lake City, Jan. 2, at the age of 59. A graduate of the University of Heidelberg, Mr. Pickel began his engineering work in Germany, working with his father, a general contractor. In 1906 he joined the staff of the Isthmian Canal Commission, first as engineer in charge of road construction and then as sanitary engineer in charge of sewage disposal drainage and water supply. He received a Distinguished Service Medal from President Theodore Roosevelt for his work in the Canal Zone. Mr. Pickel later served as chief sanitary engineer of Chile and did work for the government of Argentina in combatting tropical diseases. In 1930 he became state sanitary engineer of Utah. He joined the staff of PWA in 1933, and last summer began private practice.

IRA G. HEDRICK, consulting structural engineer prominent for 44 years in the field of large bridge construction, died Dec. 28 in Hot Springs, Ark. at the age of 69. Mr. Hedrick was educated at the University of Arkansas and McGill University and then entered bridge engineering as assistant to J. A. L. Waddell in 1892. After six years of this work, he became assistant chief engineer of the Kansas City, Pittsburgh & Gulf R. R. Co. A year later, however, he formed a partnership with Dr. Waddell to practice bridge engineering under the name of Waddell & Hedrick, an association which continued for eight years. Later he practiced in partnership with Victor A. Cochrane, as Hedrick & Cochrane. In 1915 he formed the consulting firm of Hedrick & Hedrick, and from 1919 to 1924 was also senior member of the firm of Hedrick, Smith & Frost. Among the many bridges designed by him in this and foreign countries was the Burnside Bridge in Portland, one of the first lift-span bridges with car-tracks and automatic power connections.

ORSON H. MARCHANT, of the New Haven civil engineering firm of Blair & Marchant, committed suicide Jan. 4.

JOSEPH WILDE, president of the Canadian contracting firm of Joseph Wilde & Co., Ltd., died in Toronto, Dec. 28 at the age of 56.

SAMUEL R. KIRTON, 70, architect and civil engineer and recently county surveyor of Ware County, Ga., died Dec. 27 at Waycross, Ga. Mr. Kirton is credited with the design of the Union Station in Montgomery, Ala. and was connected with the design and construction of the Union Station in Atlanta.

A. B. COLE, an engineer with the North Carolina state highway commission, located in Asheville, died Dec. 16. Mr. Cole has been connected with the State Highway Department for the past ten years.

FRANKLIN P. TATE, 70, retired civil engineer, died Dec. 24 in Morganton, N. C. A graduate of Davidson College, Mr. Tate had been active in railroad work.

CHARLES F. JORDAN, for more than a quarter of a century superintendent of the Columbus, Ga. water works, committed suicide January 4. He had been in ill health.

ROBERT C. HOADLEY, JR., civil engineer of Binghamton, N. Y., was killed in an automobile accident Dec. 25, near Jacksonville, Fla., at the age of 55. A graduate of Union College, Mr. Hoadley gained his first engineering experience on survey parties of the U. S. Geological Survey. In 1902 he joined the staff of the Western Maryland Ry. Co., serving successively as topographer, resident engineer, and locating engineer. After brief engagements on railroad and power house construction projects, he joined the New York state department of highways, as assistant and later first assistant engineer. In 1917 he entered private practice as a member of the firm of Hoadley & Giles.

IRA U. KAUFFMAN, 56, chief engineer in Georgia for the U. S. Coast & Geodetic Survey, died Dec. 27 at Atlanta. Previous to his connection with the survey, Mr. Kauffman practiced privately in Atlanta.

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Detroit Society Proceeds With Building Plans

The architectural firm of Harley & Ellington has been retained by the Rackham Engineering Foundation to design a new building to house the Engineering Society of Detroit. The building will be paid for by means of a gift of $500,000 which was given to the society by the Rackham Fund last May. (*ENR*, May 27, 1937, p. 795).

The Rackham Engineering Foundation is a body which was organized in June 1936 to administer an endowment of $500,000 granted by the Rackham Fund to the Engineering Society of Detroit when that body was organized as a coalition of several Detroit societies.

PERSONAL

A. T. COOK, general superintendent of the Passaic Valley Water Commission, will end his connection with the Commission the first of the year, when the position of general superintendent is to be abolished.

RUSSELL S. WISE, consulting engineer for the Passaic Valley Water Commission, will also leave at the same time, when his position is abolished.

LORENZ E. ORDELHEIDE, sanitary engineer for the St. Louis County, Mo. health department since July, 1936, has resigned that position to join the engineering division of the Missouri state department of health.

LEONARD M. FORD, who has been connected with the Kellogg Foundation, has been appointed sanitary engineer of St. Louis county, succeeding Mr. Ordelheide. Mr. Board, a graduate of West Virginia University, was in the employ of various counties in Michigan before he became connected with the foundation five years ago.

C. W. SMEDBURG, director of public works of Greensboro, N. C., has been appointed city manager of that city.

J. N. CHESTER withdrew the first of the year from the engineering firm of Chester, Campbell, Davis & Bankson. The business of the firm is now conducted by John T. Campbell, D. F. Davis and E. E. Bankson under the firm name of "The Chester Engineers."

F. HARPER CRADDOCK has been appointed chief of the rate section of the Rural Electrification Administration, succeeding H. Zinder, who has been transferred to the Federal Power Commission. Mr. Craddock graduated from Rensselaer Polytechnic Institute in 1917, served for several years as chief engineer of the Department of Public Works in the state of Washington, and has been employed as valuation and rate engineer by several Northwestern utility companies. He entered the service of the federal government in 1935, making cost studies for the Federal Communications Commission. In 1936 he joined R.E.A. as assistant chief of the rate section.

JOHN GRAHAM, JR., Philadelphia architect and student of public housing, has been appointed consulting architect for the housing program in the state of Pennsylvania. He will act as an adviser to local housing authorities in Pennsylvania communities. Mr. Graham is chairman of the housing committee of the Philadelphia chapter of the American Institute of Architects.

Roadbuilding Equipment Trends

Highway construction progress aided by development of faster, efficient, precision-made machines that make better roads possible

DEVELOPMENT and improvement of roadbuilding equipment in the past year or so has kept pace with the progress in highway engineering and construction. In fact, much of this latter progress has been possible because of the constant trend towards better and more efficient equipment. Not only has construction machinery been bettered mechanically, but improvements and refinements have been made that permit better controlled and more precise construction operations.

Observations reveal that three current general trends in equipment: (1) Refinements in mechanical design and selection of materials—better engineering, in other words; (2) adaption of machinery to a wider range of use through greater capacity, faster speeds, more efficient and easier operation; (3) development of special machines for new types of work. These three broad trends will be discussed briefly.

Improved engineering

Probably the most important—and least appreciated—current trend in construction equipment is that toward better engineering. This trend includes such developments as use of better steels and alloys for strength and lightness and for longer wear of moving parts; positive or sealed lubrication; more dependable operation which reduces maintenance and repair costs; refinement of accessory items, such as clutches, brakes, power units, and transmissions; restyling and redesigning for better appearance, easier access to working parts and better performance.

Construction equipment today largely rides on rubber, the culmination of a trend of several years. Exceptions, of course, are found in the larger shovels and cranes, and in certain types of haulage units; these items are carried on improved crawler treads, self-cleaning, nonclogging, well lubricated. Tire manufacturers have not simply adapted established products to construction plant—they have developed tires of the necessary size and ruggedness to meet construction requirements.

Welded fabrication

Welded fabrication of machinery has reached its highest state in the construction field. Those who attended the St. Louis Road Show in 1931 will recall the interest created by a new type of plant, an all-welded carrying scraper. This marked the first use in welded fabrication, the process now so widely used. Welding permits a better arrangement and design of structural parts, an advantage now realized by many manufacturers in all lines of construction equipment. Box and tubular members, for example, have in many instances replaced bolted and riveted fabrication, making for rigidity, strength and lighter weight.

A striking example of the trend in engineering design is given by the lowly drawn grader, which, not so long ago, was merely a wheeled frame carrying a scraper blade operated through a crude mechanism. The new design of this rig meets the demand of highway engineers for machines possessing greater strength, better balance, wider range of usefulness to meet the closer tolerances and improved finish in earthwork typical of modern highway building. Cast steel forms the parts which require unusual shape because of complicated stresses, tubular sections are used to absorb tortional and bending stresses, structural shapes make up parts subject to bending, all fabricated by electric arc welding. Principal motions are accomplished through worms and gears, cranks and connecting links. Gear cases are mounted to reduce strains and to provide accessibility. A full shift, long rear axle gives the machine added stability and gives the operator better control of the weight of the frame. Tooling of parts equals that of tractors and trucks; machined parts are built to close tolerances, and lubrication has been sealed to exclude dirt and dust. Operating speeds have been adjusted to a new tempo, and operation is eased through the use of automatic brakes.

Wider range of use

Another significant trend is toward more versatile operation, greater capacity and wider range of use of equipment. Highway engineering and construction are constantly demanding more precise and an increasing variety of operations. For example, wide and flat backslopes, shoulders and ditches are becoming standard design, which requires excavating, grading and finishing equipment capable of fast but precise operation. The equipment industry met the need by promptly adapting the regular types of graders and excavators to the refined requirements—machines that would handle the special operations in addition to routine work.

Increased output and greater capacity has resulted from two trends—first, in larger sizes of individual units, a very pronounced development; secondly, through faster and easier operation of units without increasing their size. The huge public works projects of the past few years have had a profound effect on equipment development. Larger capacity units were required to handle the tremendous volume of work on a single project. Concrete mixers and buckets, shovels, dredges, carrying scrapers and other units were increased in size to meet the demand for greater output. However, these

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large plant items were so well and efficiently designed that they have found their way onto the smaller projects. Today, for instance, we find dirt-moving units of 15-cu.yd., or even greater capacity, on jobs that only a short time ago would have been considered all too small to support such large units.

Faster operation

Yet increase in size is but one way in which output has been stepped up—faster and smoother operation is the other. A $\frac{3}{4}$-yd. shovel today, as an example, will dig as much material in a given period of time as would a 1-yd. or $1\frac{1}{4}$-yd. rig a short time ago. It is lighter, more mobile and much faster than its predecessors. It has an alloy steel boom and bucket, lighter in weight than the older design, which means a reduction in counterweight with less mass to swing and move. Trucks and tractor-wagons move faster than formerly, resulting in increased haulage capacity without increase in size. Trucks, by the way, are now designed for construction operations, and are not simply a general hauling unit transferred to a special field.

Carrying scraper

The carrying scraper has become a major element in excavation. This rig, because it digs, transports, dumps and spreads the material is a favorite dirt-moving unit. Increase in capacity and better performance have kept this type of machine to the front, though once it was threatened by the growing output capacity of shovel-truck and shovel-wagon lines of dirt movers. Even the old-time elevating grader that grew to popularity in the mule-team railroad building days has come back because it fits in with modern haulage methods.

Speeding up of one construction operation affects the train of operations following in its wake. This can be illustrated by the use of larger, faster or multiple paving mixers. Faster mixing and placing of a concrete road slab requires faster preparation of subgrade, setting of forms and joints, screeding and finishing. Each of these allied operations requires its own equipment items. Development and improvement of these

accessory units has more than kept pace with that of the major plant. Look, for instance, at the ordinary road pump that has now grown into a husky and dependable unit that keeps a constant high-pressure flow at the end of six or seven miles of 3-in. pipe without faltering. Finishing machines now screed, tamp and finish the slab in one operation, some finish on the backward run as well as forward to save time, others use a wide screed to do a better job in shorter time.

Specialty plant

Construction operations are ever becoming more complicated, more diversified. As pointed out above, much construction equipment has been improved to meet this changing technique. However, there are a growing number of operations that call for special plant items, and to the credit of the equipment industry, specialty units are made available as fast as the need for them comes into being.

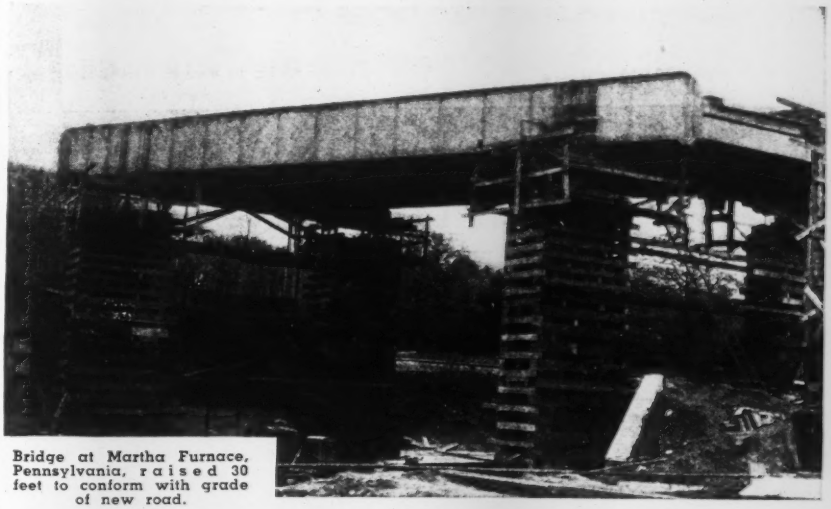
Subgrade stabilization is an operation that requires special plant. This is a recent development in roadbuilding, and even as late as last season makeshift plant was found on most projects of this type. However, one manufacturer has already come out with a complete coordinated plant for chemical and cement stabilization, and others have announced they will be on the market with similar equipment by the time the coming season opens up. A suboiling machine has been developed for bituminous base stabilization, and traveling bituminous mixing plants have also been adapted to this special kind of construction work.

More special equipment

We are now entering an era of salvaging, rebuilding and widening existing highways, which calls for special equipment. Excavators for widening the roadway, rollers for tamping the widening trenches, spreaders and drags for applying and finishing surface mats are all recently-developed special plant items.

The list of specialty units might be extended much further. Subgraders, guard rail post hole diggers, mud jacks, concrete pumps, hillside trench diggers, small power shovels and truck shovels for maintenance work and snow plows should be included.

In Highway Construction Calling For...



Bridge at Martha Furnace, Pennsylvania, raised 30 feet to conform with grade of new road.

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And, of course, the whole field of bituminous road construction requires specialty items.

Specific developments

There are developments and improvements along specific lines, distinctive from general trends, that cannot be ignored. The dual-drum paver is an example. The first dual-drum unit was produced in 1932, but the depression stopped further development until 1937. This past year saw a revival of not only the older 27-E size in the dual-drum type, but also larger units of 34-E size. One manufacturer is now working on a 40-E unit. These rigs greatly increase the mixer output and result in mixing economy. It is recognized, however, that the mixer is not usually the bottle-neck of paving operations, and unless the contractor speeds up other operations accordingly, the increased efficiency will be lost. This fact may affect the future development of these interesting construction plant items.

The switch to diesel power is another specific trend. Diesel engines, already a favorite for tractors, shovels and heavy haulage units, are now going into air compressors, trucks, hoists and other units.

More air compressors

Air compressors of the portable type are growing both smaller and larger. Highly mobile, two-wheel rigs are becoming popular for the isolated small job, or even the large job where need of air is scattered and irregular. A semi-portable size for use on a job too large for the standard portable and too small to warrant a stationary plant installation has recently been produced.

These are but a few of the improvements and developments that can be included in a short summary of the progress in the equipment industry. The same forward progress is to be found in every line of construction equipment from the smallest tool and accessory to the largest plant item. The trend will be vividly portrayed at the Road Show of the American Roadbuilders Association to be held in Cleveland next week. A full account of the exhibits, made from personal observation, will be carried in *Engineering News-Record's* issue of Jan. 27.

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